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A New Drill Grinder.

Our illustration shows a drill grinder which possesses some points of novelty worthy of attention, and seems to bid fair to contribute not a little toward the solution of the problem of a twist drill grinder simple in construction and at moderate cost, capable of grinding accurately, twist drills having a range of sizes such as is generally used in the average shop.

No chuck is used with this grinder, at least nothing similar to the ordinary drill chuck, but, instead, the adjustment for various drill sizes is obtained by an ingenious and simple combination of angles in the sliding holder, and there is a pointer, which, in connection with a graduated scale, shows when the holder is set for the size of the drill to be ground.

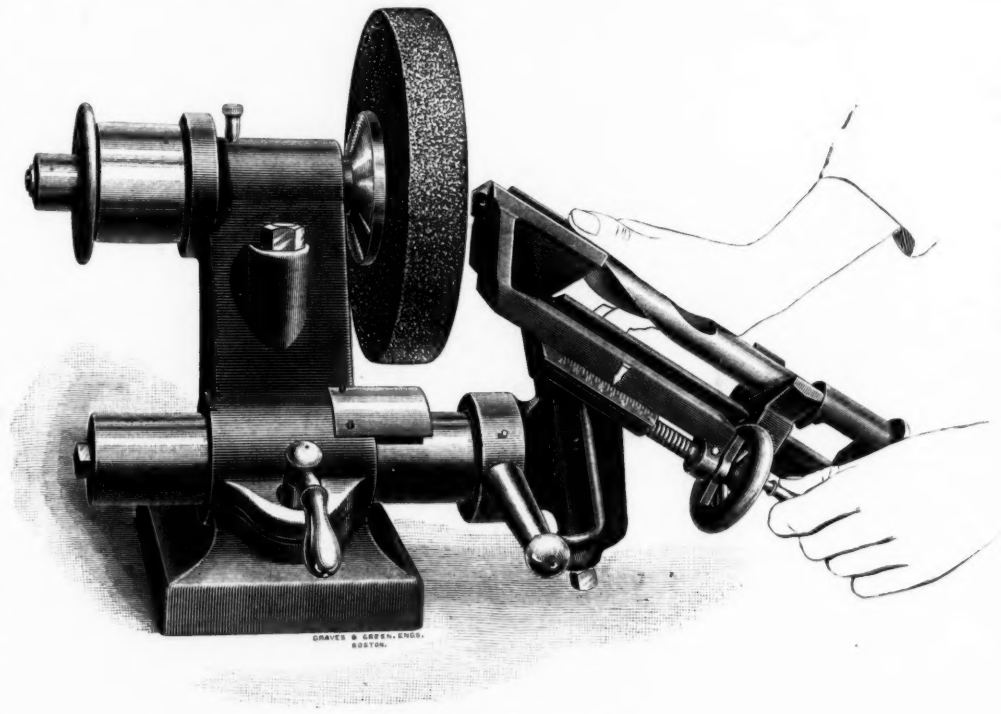
There is no adjustment of chuck holders, it being necessary, after the adjustment spoken of above is made, only to drop the drill into place and proceed.

The machine will grind any size drill from ¼ to 2 inches, and will so hold them as to make the point true with the body of the drill.

The rest for the shank can be instantly adjusted to bear upon that part which is true, or nearest so, and the end stop is adjustable for any length of drill from 16 inches down to a mere stub.

The accuracy of the grinding is independent of the bruised, broken, or otherwise imperfect condition of the end of the shank.

As the cut shows, the general design of the machine is simple. The wheel spindle has a conical bearing, adjustable for wear, and extending nearly through the belt pulley. The emery wheel is of the cup form, and the drill is applied in such a manner that its correct grinding does not depend upon the accuracy of the wheel surface.



A NEW DRILL GRINDER.

In operation the workman places the drill in the V-shaped holder, sets the pointer on the scale to a figure corresponding to the diameter of the drill to be ground; with the thumb of the right hand he places the drill with its lower cutting lip against a projecting gauge, which secures its correct position at once. He then slides the drill holder towards the wheel, till the drill nearly touches it, when it is clamped by the handle at the left. The grinding is then done in the manner indicated in the cut, the correct form of cutting lip being obtained by rocking the holder and drill about a vertical axis; at the same time it is fed forward by the hand wheel. The amount ground off is gauged by the hand wheel. After the first lip is ground, and before the drill is backed away from the wheel, a pointer is set, which, when grinding the second lip, is brought to the same position, and thus uniformity between the lips is secured.

A drill point ground on this machine has a helicoidal surface which is similar in form to the bottom of a hole when the drill is at work cutting its chip. Thus the proper clearance is secured for drills of all diameters. It grinds the drill to the angle recommended by the leading manufacturers, viz., 59°.

It is made at the Washburn Machine Shops, of the Worcester Polytechnic Institute, Worcester, Mass.

Practical Details of Blacksmithing.

BY B. F. SPALDING.

NATURAL GAS—PRODUCER GAS—A BAYONET SOCKET FIRE—ECONOMY OF HOT BLAST—ELECTRIC WELDING—DROP FORGING STRAP HINGES.

The operations of blacksmithing are more expensive than those of most of the other trades, on account of the cost of fuel which it is necessary to use to reduce the hard and stubborn material which it is their object to shape, into a yielding and workable condition. In places situated in those favored localities where natural gas is to be obtained at prices modified by competing interests, these operations can be carried on with an economy proportionate to this advantage.

The blacksmithing to be done in the manufacture of most of the articles, which are the greater products of the mechanic arts, constitutes, however, but an insignificant proportion of their expense. The other work may be done with greater facility elsewhere, or it may be that material can be obtained to greater advantage; or any one of a thousand circumstances may present itself, to make it a matter of expediency to locate the manufactory at a distance from the fields of natural gas. In fact, a great many of them happened to be so situated when the gas first blazed its way into notoriety. It became necessary, therefore, to meet this state of things, that something should be found to compensate for its absence. This led to experiments, which resulted in the inexpensive extraction from the refuse of coal of what has been termed producer gas, which appears to give satisfaction to those who have used it. In places where this can be obtained as economically as it is said to be by some of the large manufacturers in the vicinity of Philadelphia, the fuel item of expenditure in the cost of working iron and steel is reduced to a minimum. The reason of this must, however, be found in the present low price of what has been the refuse. When this is found to have a value it will have a price, and upon this price will depend its economy. If it then has any advantage over the old method of producing the gas and using it in its nascent state, or just as it is made, it will be because it is caught and confined to the point where its combustion will give the best results. It is not always possible to do this with the gas at the temperature at which it is evolved, as the pieces to be worked are of such shape as require an open fire for the convenience of handling them, and this, of course, prevents the concentration of all the combustion. In such cases, which constitute the majority, much of it goes to waste, and the loss thus involved may be greater than the expense of otherwise producing and securing it.

There are some kinds of work where the furnaces may be so constructed that but little heat is wasted. An instance of this kind is in the welding of bayonet sockets. A section of a furnace of this description is shown in Fig. 1, page 2.

Here it will be seen that the aperture in the grate is quite small, and the blast is concentrated beneath the small opening in the firebrick top, in which the bayonet socket is laid to be heated. The lap on which the weld is to be made is on the side of the socket next to the fire. The furnace is so constructed that there is a body of coal on each side of the grate, which is heated by the burning coal to such an intense temperature that no diminution of the heat at the opening in the top, which is the focal point, is occasioned when it is moved forward, with the poker, to take the place of that which is consumed. The amount of air which is blown in being small, but coming in a sharp blast, there is none to spare on either side, but the chemical changes of combustion take place in its direct path, and when it reaches the bayonet socket, or whatever is placed at the focus, it is in a very high state of concentrated heat. There is no smoke, no escape of free carbon. In an unventilated apartment there is a strong smell of sulphur and of phosphorus. These are the most palpable to the senses. The other products of combustion are carbonic acid and the nitrogen, which is freed from its combination by the desertion of the oxygen from the air, and which must be heated to the high point of temperature maintained at the small aperture at the top, which affords it the only outlet of escape. The waste of the heat which is required to do this appears to be in this instance all that can be saved by any improved method of evolving heat from coal.

The great improvement in smelting furnaces, the hot blast, effects this saving by utilizing the escaping heat, after it has done its work in the furnace on the metal, to heat the air for the blast before it is brought to combine the fuel. It may be that a further application of this principle can be profitably made and give good results not only in blacksmiths' furnaces but also under steam boilers, and in the latter get quick evaporation with all the economy now gained by slow combustion. But while the great oil companies stand ready to make 10 year contracts to furnish fuel oil at 15 cents a barrel from the Lima fields, there is not an urgent necessity for economy.

Where there is an unlimited supply of natural gas on still more favorable terms there also is no demand for appliances of this nature. To obtain a very intense heat with the gas, it could be fed with a stream of pure oxygen, on the principle of the compound blow pipe, the heating of the nitrogen in this case being avoided by not letting it go to the fire. Short heats might be taken thus, with perhaps as much economy as with the electrical current. The economy of heating with electricity, if there is any, must lie in the ability to take very short heats, and in the perfect control which the operator has of the heating power. It may be held to be an axiom in mechanics that the most direct connection between cause and effect produces the greatest results. The interposition of any means between these must consume some of the power, yet there may be compensations, as in the case of electric welding, which will make up the loss. The more this proves to be the case the greater will be the success of Tubal Cain in breaking the fiery steed to go in a cart.

In a certain establishment there arose a demand for wrought-iron strap hinges for a new model of a machine that was to be built. It was at first designed to make them solid, or at least to weld them back of the eye, but this was abandoned as too costly. It would require some time to take the heat and some time to work it, and time is money. Perhaps if an electro-dynamo could have been run with the Keely motor, and the straps have been put in it and struck welded by lightning, the plan might have been adopted. It is not probable, however, for it would have been a useless expense. Strap hinges are, in every way, as good without being welded if the first bolt the

one next to the eye, can be brought near enough to the eye to keep the strap from springing. A machine was devised and a working drawing made of it for making them without welding. The estimated weight was about a thousand pounds, and the cost from eighty to a hundred dollars. The process would have been quite simple if made with this machine. The stock would have been cut off from $1\frac{1}{2}'' \times \frac{1}{4}''$ rounded on both ends, and the pieces, after being heated, would have been presented to a pin on the machine, with tongs which gauged them from the back end. Then, by operating the treadle, the machine would have gone to work, and the end would have been bent around the pin, as shown in Fig. 2.

It would then have been laid in a pair of horizontal moving dies at the side of the machine, and a side bend made in it, as shown in Fig. 3, which would have completed it.

The estimated cost of the machine was surely not exorbitant, and it would have been prudent to have made it, if there had been a surety that the number of hinges required would be great enough to pay in the savings over other methods for the machine. As this was not certain it was decided not to incur the risk, but to make them with the general tools of the shop, and therefore dies were made of cast-iron, at considerable less cost, for the purpose of making them with the drop. This expedient succeeded very well. The pieces having been cut to the right length and rounded on both ends, were placed in a part of the die, which was shaped as is shown in Fig. 4.

The slight preliminary bend on the end of the piece was given to it by the heater as he took it from the fire. The round pin *A* kept it from flying up, when the top die struck it to bend it to the shape shown by the dotted lines. A $\frac{1}{2}''$ pin was now laid in the bend, and the strap was then put in another part of the lower die, shown in Fig. 5.

The half-inch pin being three inches long, it stuck through the hinge $\frac{3}{4}''$, more or less, on each end. The impression in the die for the formation of the eye of the hinge was only $1\frac{9}{16}''$ wide, but there were recesses left for the reception of the pin, and this, lying in these recesses, kept the hinge back into its place to receive the blow of the drop die which gave it the shape which is indicated by the dotted lines of the figure. It yet remained to put the side bend into them, and this was done by putting them into the part of the die shown in Fig. 6, which was done immediately, while the pin remained in the eye.

The hinges were rights and lefts, but they were all bent in the same die, as all that was necessary to make the difference was to turn the fold of the strap toward the outside to make one kind, and toward the inside to make the other. There was a hole of the size of the pin in the lower die, and the only trouble to be apprehended was that when the upper die descended the pin might not enter the hole in that die which was intended for its reception, and for this reason the hole in the lower die was made deep enough, so that in case of accidentally tipping the hinge to one side, it should throw the pin out of line with the hole and cause it to be struck on one side; the pin would not indent the top die, but descend into the lower die, as of course there would never be any difficulty in getting it into that. In practical use there was no trouble, as the ends of the pins were made so tapering that, unless they were held very much out of the way, they were sure to enter. After they had received a blow in this die, they were returned to the die shown in Fig. 5, which recovered for them the shape which had been somewhat changed by the effects of the side blow. The pin was then knocked out with the little jumper shown in Fig. 7, and, falling in the water in the box beneath, was cooled at once, and was left in a convenient position to be readily placed in the bend of the next hinge. As this light jumper with its coiled wire spring is handy and cheap, I have made a drawing of it. These little matters, that are merely conveniences, assume exaggerated dimensions when there is much to do and time is limited. It very often happens that the little things which facilitate operations amount to more in the way of getting out the work than the main design, of which they seem to be but an insignificant part.

The holes in the hinges were punched after they were cold in about the relative positions shown in Fig. 3. There was no trouble in punching through the double thickness with a $\frac{7}{8}''$ punch.

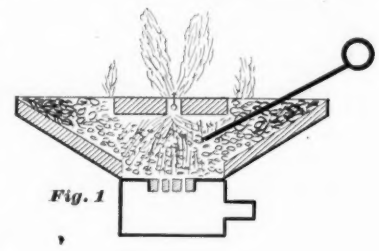


Fig. 1

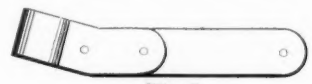


Fig. 3

Fig. 2

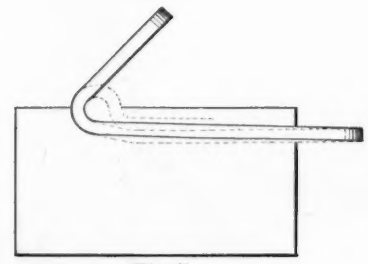


Fig. 5

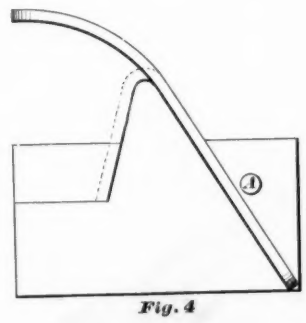


Fig. 4

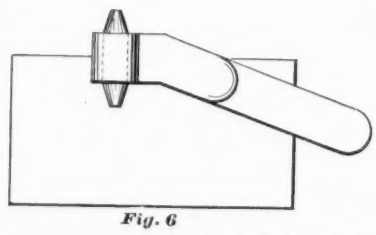


Fig. 6

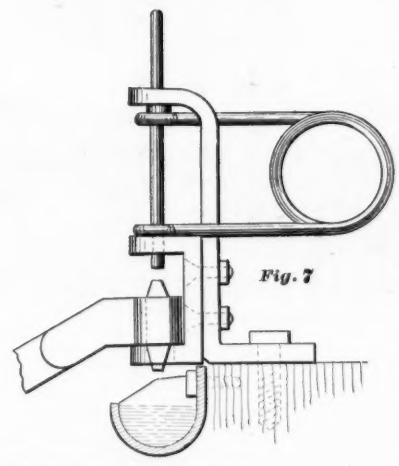


Fig. 7

PRACTICAL DETAILS OF BLACKSMITHING.—SEE PAGE 1.

Notes on the Cincinnati Exposition—The Government Exhibit.

Among the things to be seen at the Cincinnati Exposition which do not come under the head of machinery, yet are interesting to machinists and others connected with machine construction, may be mentioned the department at one end of "Old Power Hall" devoted to showing the natural resources of the State of Ohio; an inspection of which will quickly convince any one that the gigantic strides made by the State, and the important position she has taken in manufactures, are sufficiently accounted for by the generosity with which nature has provided her with all the things necessary for manufacturing.

Specimens of the different varieties of coal and iron ore found in the State, as well as other minerals, are there; also specimens of the different kinds of timber, rough and finished; together with charts, geological models, etc., to show the distribution and amounts of them available. On the floor of this department is a model of the State, made in plaster and colored. It is about 15 feet square, and shows the physical characteristics of the State quite distinctly, every valley or elevation of any importance being shown, as well as the streams of water, which are represented by actual streams of water on the model. The natural gas regions are represented by small gas jets issuing from holes made in the model, and kept constantly burning.

Many of the farming, household, and manufacturing implements used in the State at an early day are shown, and make a very interesting and instructive exhibit. The Ohio State University has an interesting exhibit, including some physical apparatus.

Specimens of the goods made in the Ohio penitentiary are exhibited, together with models of different parts of the buildings, and articles used there, including a rope bearing a card certifying that it had been used for hanging two men. As to just what the object of showing this latter article may be we are left in doubt, as it is not stated that the rope is of Ohio manufacture, nor that the material of which it was made was grown there, and in appearance it very much resembles the ropes used for the same purpose in other States.

In the upper floor of this building is an extensive display of the work done at various trade schools, which consist of samples of blacksmith work, iron founding, pattern making, machine building, plumbing and drawing. The schools represented are the Rose Polytechnic Institute, Cleveland Manual Training School, New York Trade School, the Technical School of Cincinnati, and the Chicago Manual Training School.

Many of the things shown are quite creditable, especially the drawings.

In the Park building there is little of interest to our readers in a mechanical way, except that which is included in the Government exhibit. The Black Diamond File Works have a large case of files, showing a great variety of them of their manufacture, from fine files four inches long up to files six feet long and two and one-half inches wide, made to receive a handle at each end, and evidently to be used by two men, in the cross-cut saw fashion.

There is also an exhibit of steel pipe from the Riverside Iron Works, Wheeling, W.Va. Specimens are shown which have been coiled and subjected to other bending operations while cold, and showing remarkable tenacity and homogeneity.

The Wickman Envelope Printer and Folder, made in Hartford, Conn., which is shown in operation near the exhibit of the Post Office Department, attracts a great deal of attention, and is a very interesting machine. It takes the blanks, which have been previously cut out the proper shape, and gums them, prints the Government postage stamp upon them, and folds them ready for use, delivering them standing up side by side in a box, with every twenty-fifth one drawn out further than the rest, to mark the completion of a package. This it does at the rate of 4,500 envelopes per hour.

Time and space forbid the mention of more than a very small fraction of the interesting things shown by the Government, but, confining ourselves to those which are of interest more especially to the mechanic, there are 27 cases of models of machinery, chosen with especial view to their interest, among which are to be seen the original models of some machines and devices which have, since they were constructed, made their mark upon the history of our times. Among these is a model of a patent granted to M. W. Baldwin, in 1842, for a "locomotive engine adapted to curves"; one granted to Hoe, in the same year, for a double-cylinder printing press; Howe's original sewing machine model; one of Whitney's cotton gin, Morse's telegraph instrument, and many others of great interest, which it is impossible to mention in detail. Six of the cases are devoted to models of agricultural machinery, among the notable models to be seen among them being the one of Appleby's grain-binding and tying device, for which invention nearly every manufacturer of self-binding reapers in this country pays him a royalty.

A very interesting feature of the Government exhibit is the department which shows the development of the modern methods of travel and transportation of goods. Pictures, models, and in some cases actual specimens of the things used for the purpose in former days are shown, commencing with a life-size model of an Apache squaw, bearing upon her head a basket loaded with goods, as being the earliest known American method of transportation, and showing, by models, pictures and specimens, the transformation from that through the Indian pony, having two poles attached to him, the ends dragging over the ground behind, and called a travoau, the pack mule, emigrant wagon, stage coach, the earliest forms of engines and cars, including half-size models of Peter Cooper's engine "Tom Thumb," built in 1830, and one of the "Grasshopper" engines as used on the B. & O. Railroad in 1831. There is also a model of the first steamboat used on the Ohio River, a stern-wheeler, named the "Orleans," and dated 1812; and some of the original stone blocks, with parts of rails fastened to them, which composed part of the tracks of the B. & O. Railroad in 1828, the Camden & Amboy road in 1831, and the Portage Railroad of about the same time. The first named is a strap rail, the others somewhat similar in form to our T-rails, except that they are without the broad, flat flange on the bottom, and are supported in chairs. There are also the tubes of the original multi-tubular boiler constructed by John Stevens in 1825, and sections of the various shapes of rails which have been used from the earliest days of railroading to the present time.

The Navy Department have wooden models of the five, eight and ten-inch rifled guns, and a number of machine guns and instruments used in navigation and hydrographic surveying. They also show four beautifully finished models of the new government cruisers. They are complete in every detail, so far as what is to be seen from the outside is concerned, and being something over four feet long, are large enough to show the construction quite well. Models of the "Baltimore" and "Newark" are included, the other two vessels not being yet named. There is also shown some of the arms used by land forces, including one of the latest breech-loading rifled field pieces, made entirely of steel, and very nicely finished.

The U. S. Coast and Geodetic Survey have what is to the mechanic, far the most interesting part of the exhibit. They show a large number of instruments used in the prosecution of the coast survey work, including the famous base measuring apparatus used for measuring base lines for triangulation, and by the use of which such wonderfully accurate results have been attained in the measurement of long lines; four theodolites of various sizes and constructions, used for measurement of angles; instruments used for accurate leveling over long lines; a gradientor; two heliotropes, used for making the position of distant stations ascertainable, or rather making them visible through the instruments used; a zenith telescope, for de-

termination of latitude; forty-six inch transit, for determining longitude in connection with telegraphy; Saegmuller's prismatic transit; chronograph; personal equation apparatus; a number of pendulums, such as are used in scientific investigations, besides numerous minor instruments for recording the movement of tides, direction and velocity of ocean currents, etc. There are also sample sets of the weights and measures furnished by the Government to each State and to each State agricultural college.

Most of these instruments have been in use for some years past, and are sufficiently familiar to require no description.

What is called the reflecting comparator is, perhaps, of most interest to our readers, and though it is by no means new, a short description of it will probably not be without interest. It has been used for the final comparison of standards of length, and consists of an abutting screw fitted with a micrometer head, against which one end of the piece to be measured is placed. Against the other end comes a sliding abutting piece, which is held to contact by spring pressure. At the side of this sliding piece is a small vertical axis, which carries at its upper extremity a small mirror. Around the axis passes a fine chain, both ends of which are attached to the sliding piece in such a manner that any endwise movement of the slide causes the mirror to rotate. A small screw on the side of the slide, to which one end of the chain is attached, provides for keeping it tight. At a considerable distance from the mirror (some six or eight feet in this case) is mounted a small telescope, directed toward the mirror, so that anything reflected by it will be seen through the telescope. Just beneath this telescope is fixed a scale, which is curved to conform to the arc of a circle, the center of which is at the center of the axis upon which the mirror turns. The telescope being provided with a cross-hair, to define the line of vision, that part of the curved scale which is opposite the plane of the mirror will be reflected by it, and seen through the telescope. Some certain division of the scale can, by means of the micrometer screw, be brought to coincide with the cross-hair; any different position of the mirror, however slight, will cause a different division to coincide with the cross-hair, and thus, owing to the distance between the mirror and the scale, very small differences in lengths of the pieces tested are magnified and made plainly apparent. Of course the above is simply a description of the essential parts of the instrument, sufficient to show the principle upon which it is constructed. The "personal equation apparatus" is something new, and is worthy of some notice. In order to make its action plain to our readers, it will be necessary to explain an instrument used in connection with it, which, though it has been in use for a number of years in connection with astronomical work, is not familiar, except to those who have been in some way connected with such work, or with the making of such apparatus.

This instrument is known as the chronograph, and consists essentially of a cylinder of brass, usually about twelve or fifteen inches in length and six inches in diameter. It is provided with means whereby a sheet of paper may be fastened to it in such a manner as to entirely cover its outer surface. At one side of the cylinder, and parallel with it, are two slides, upon which is mounted a small carriage, moved along the slides by a screw, in much the same manner as a lathe carriage. The cylinder is revolved slowly by the action of a weight and suitable gearing, uniformity of motion being secured by a delicate governor. A pendulum and escapement cannot be made use of, because an uninterrupted motion must be secured. The cylinder and the screw which moves the carriage are connected by gearing, so that as the cylinder is revolved the carriage is moved at a uniform rate. Mounted upon the carriage is an electro-magnet, and an arm carrying a pen, which, when the instrument is in use, rests upon the paper, and, owing to the motion of the cylinder and carriage, would trace a spiral line upon it similar to a screw thread. But the electro-magnet is so arranged that, when the circuit is broken, the pen is deflected laterally and a sharp notch made in the spiral line. The magnet is connected by wire to the astronomical clock in such a way that each beat of the clock pendulum breaks the circuit for an instant, and thus there is a series of notches in the spiral line, each representing a second of time.

There is also a break-circuit key provided, which may be taken to any part of the room, and by means of which the observer may, at any instant, break the circuit and cause a notch to be made similar to those caused by the pendulum of the clock.

The telescope of the transits, used for determining longitude by means of ascertaining the exact time of the passage of a star across the meridian of the place, are provided with a number of vertical lines, which, when looking through the telescope, appear to extend from the upper to the lower limits of the field. They are usually formed by spider webs, which are stretched across suitable rings, which are adjustable within the tube of the telescope. The middle line is adjusted to be in the exact center or line of collimation of the telescope, and thus, as the latter sweeps from north to south, traces a line through the sky, which is the meridian of the place. The other lines are at equal distances each side of it.

When the transit of a star is to be observed, the observer, looking through the telescope, and with his finger on the key (the chronograph being in motion), breaks the circuit at the instant of the passage of the star over each line, and the position of the notches thus made in the spiral line, compared with those made by the pendulum of the clock, shows the time of the transit; the *average* position of the notches made by the observer being taken for the true position of the central one.

It has been found that few, if any, observers thus record the true time of the transit of a star or other body; some slightly anticipating the exact passage over the lines, others being too late; but this error, while differing considerably among different observers, is reasonably constant for the mean of a number of observations by the same observer, and it is to ascertain, and thus be able to make the proper allowance for this error, that the "personal equation apparatus" was designed by the late Superintendent of the Coast Survey, J. E. Hilgard.

The chronograph used in connection with this instrument is the same as the ordinary chronograph, except that it has two carriages, both moved by the same screw, both pens being in the same circuit, which is broken by a chronometer, thus making the notches in both spiral lines exactly agree with each other.

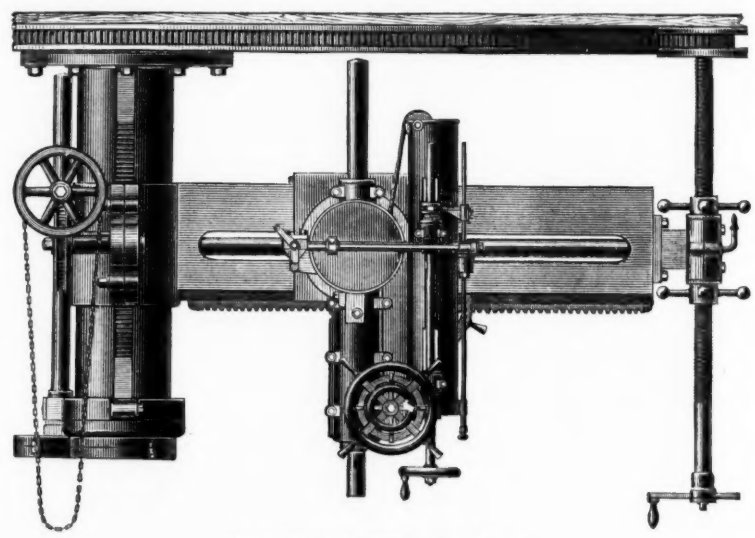
The "personal equation apparatus" is provided with a small telescope, having a field crossed by lines the same as the telescope of a transit instrument.

By suitable clockwork, an artificial star, the light to form which is furnished by a lamp at the side of the instrument, is made to move across the field of the telescope and cross the wires at about the same rate as a real star crosses the field of a transit telescope. The star crosses one way, and then its motion is reversed, and it crosses and recrosses, as often as may be desired. At the instant of the crossing of this artificial star across one of the lines, the instrument automatically breaks the circuit and causes a notch to be made in the spiral line drawn by one of the pens, while the observer, whose personal equation is to be determined, looking through the telescope, breaks the circuit and causes a notch to be made in the other spiral line as nearly as possible at the time the transit appears to him to take place. A chronometer breaks the circuit for *both* pens every second, and thus the distance between the notches made by the chronometer and those made by the apparatus at the moment of the artificial star's passage, when compared with the distance between the notches made by the observer and those made by the chronometer, gives the personal equation of the observer, which, by measurement of the distance, may be reduced to fractions of a second.

Universal Suspension Drill.

The machine shown in the accompanying cut is designed for the use of machine shops, bridge works, etc., where large and heavy pieces are to be drilled or bored at one setting and an entire clear floor space is a desideratum.

It possesses a number of features which are new, and will, we think, commend themselves to those who are interested in, or have use for, such machines.



Universal Suspension Drill.

What might be called the base or foundation of the drill is a large circular cast-iron disk—only half of which is shown—equal in diameter to the circle described by end of arm, made with gear teeth on its periphery, of hollow box section, strengthened further by radial internal ribs, and by these means forms a firm support for the weight of the entire machine, and also a rigid truss to resist the upward pressure on the rest of the drill.

The column carrying arm, etc., is strongly bolted to center of disk. By means of a small hand chain passing over a pulley which is connected to the pinion which engages with the vertical rack through a worm and worm wheel; the arm can be raised or lowered to any point on the column.

At the opposite or outer end of arm is a screw, the upper end of which has a double flange pinion closely fitted vertically to the large disk, and sliding through a bushing in the box at end of arm. Above and below this bushing are two lock nuts provided with handles which, when screwed up on bushing, prevent either sagging or upward movement of arm.

By means of a handle on lower end of screw, the pinion above may be rotated and arm caused to describe a complete circle without disturbing the vertical adjustment.

The head can be set to drill at any angle or traversed the entire length of arm, is provided with automatic feed and quick return, and the weight of the spindle is counterbalanced.

Power for driving is conveyed from appropriate overhead works through a shaft which passes down through the center of column, and thence by means of spur and miter gears to the spindle.

The machine shown will drill to the outside of a 10-foot circle, and has sufficient power to drill a 2¼-inch hole in solid metal.

For further particulars, address Wm. M. Moore, Hamilton and Belden streets, Cleveland, Ohio.

Hints on Working Steel.

The well-known steel makers, Miller, Metcalf & Parkin (Crescent Steel Works, Pittsburgh, Pa.,) have sent us from their New York office, 480 Pearl street, a card designed for tool workers, that contains so much that is good that we reprint it entire, as follows:

Don't forget to specify the purpose for which steel ordered is to be used. You have no idea how much more likely you are to get just what you want by doing this.

Don't forget that the grain of a well-hardened and broken piece of steel is much finer than that of the bar it was taken from. If the grain is as coarse as, or coarser than, the original bar, the heat used (whatever it may have been) was too high to refine the steel in hardening.

Don't decide the quality of any bar of steel by the appearance of its grain. The coarseness or fineness depends much more on the heat at which it left the hammer or rolls than on its quality.

Don't try to harden any bar of steel without first removing the scale from it. You will certainly be disappointed if you do, as the outside is likely to be soft enough to file easily.

Don't try to harden large tools in a small bath or still water.

Don't hesitate to ask us for a copy of our "Condensed Suggestions for Steel Workers." Its contents apply to any steel you use, and it is sent free of charge.

La Metallurgie gives the following receipt for cold solder: Precipitate copper in a state of fine division from a solution of sulphate of copper by the aid of metallic zinc. Twenty or thirty parts of the copper are mixed in a mortar with concentrated sulphuric acid, to which is afterwards added seventy parts of mercury, and the whole triturated with the pestle. The amalgam produced is copiously washed with water to remove the sulphuric acid, and is then left for twelve hours. When it is required for soldering it is warmed until it is about the consistency of wax, and in this state it is applied to the joint, to which it adheres on cooling.

Attempts have been made to a considerable extent to substitute metal for wooden ties on railroads, but it does not yet appear that the right kind of tie has been invented. Wood appears to possess the quality of yielding in just about the right degree, and a metal tie should come as near to the same degree of yielding as possible. The way the railroads are using up the stock of available timber should be an incentive to some ingenious inventor to bring out a metal tie equal to a wooden one.

Along with the probability of good crops in this country comes the probability of poor crops in Europe. It may be the farmers' turn this year. If it forces us to pay a little more for what we eat, it ought to make wages enough better to balance it.

The German Navy consists of 13 iron-clad war ships, 14 armor-plated transports, 77 torpedo boats, 8 frigates, 10 corvettes, 5 cruisers, 5 gunboats, 6 dispatch boats, and 10 school ships.

The Pennsylvania Railroad Company, true to its instinct to fight the Baltimore and Ohio at every opportunity, has begun suit against the Arthur Kill Bridge Company for $5,000,000.

A Minneapolis architect proposes to erect a building twenty-eight stories in height.

Modern Locomotive Construction.

BY J. G. A. MEYER.

SEVENTY-THIRD PAPER.

In the previous examples we have made the diameters of the main rod bolts equal to one-third of the width of the rear strap as nearly as possible. The rear strap, as we have stated before, is generally made a little wider than the front one, so as to make the former stronger than the latter; the reason for this will be presently explained. But, although the width of the rear strap differs from the width of the front one, the diameters of the bolts through the rear end of the rod are nearly always made equal to the diameters of the bolts through the front end, when such are used.

Again, in the previous examples, the diameters of the bolts and their number were made to suit a maximum steam pressure of 120 pounds per square inch of piston. The stress of 8,000 pounds per square inch of the cross-sectional area of the bolts was also established; and since this stress should not be changed, no matter how great or small the maximum steam pressure in the cylinders may be, it follows that the rules, previously given, for determining the diameters and number of bolts through the main rod, are also applicable when the maximum steam pressure in the cylinder is greater or less than 120 pounds per square inch. When the steam pressure is greater than 120 pounds per square inch, then we shall generally require three bolts through each end of the main rod for locomotives having cylinders 17 inches in diameter and upwards. Since the greatest number of bolts used through each strap is three (at least we have not met with cases in which this number was exceeded), the problems for solution may present themselves in the following form.

Example 88.—Three bolts are to be used through one end of a main rod for a locomotive having cylinders 18 x 24 inches: The length of the main rod is 90 inches; the maximum steam pressure in the cylinder is 160 pounds; the vertical distance below the center line of motion of the piston through which the center of axle can move is 3 inches. It is required to find the diameters of the bolts.

In the 71st paper we have stated that the shearing force to which the bolts through one end of the main rod are subjected is represented by the length of the hypothenuse $c\ b$ of a right-angled triangle, Fig. 430, in which the length of the side $a\ b$ represents the total steam pressure on the piston; hence our first step, in the solution of our problem, will be to find the lengths of the sides of such a triangle. In the 71st paper we have stated that the length of the hypothenuse must be equal to the length of the connecting rod; hence, in this case the length of the hypothenuse must be 90 inches. The length of the side $a\ c$, that is, the shortest side, must be equal to the sum of the length of the crank, and the vertical distance below the center line of motion through which the center of the axle can move; hence, according to the conditions given in the example, the length of the side $a\ c$ must be equal to $12 + 3 = 15$ inches. The length of the side $a\ b$ must be found by calculation as explained in the 71st paper, thus:

Remembering that the length of the hypothenuse is 90 inches, and the length of the side $a\ c$ is 15 inches, we have,

$$\sqrt{90^2 - 15^2} = 88.74 \text{ inches,}$$

which is the length of the side $a\ b$.

Now, having found the lengths of the sides of the right-angled triangle, we can easily determine the shearing force to which the bolts are subjected; thus:

The area of a piston 18 inches in diameter is equal to 254.46 square inches; therefore the total pressure on the piston at 160 pounds per square inch will be equal to

$$254.46 \times 160 = 40713.60 \text{ pounds.}$$

According to the remarks in the 71st paper, the length of the side $a\ b$, namely, 88.74 inches, represents a pressure of 40713.60 pounds; that is to say, the length of the side $a\ b$ represents the total steam pressure on the piston. But we also know that the maximum pressure on the main rod is represented by the length of the hypothenuse of the same triangle, and that the maximum pressure on the main rod is as much greater as the length of the hypothenuse is greater than the length of the side $a\ b$. Hence we have

$$\frac{40713.60 \times 90}{88.74} = 41291.68 \text{ pounds,}$$

which is the maximum pressure on the main rod; and this pressure also represents the total shearing force to which the three bolts are subjected.

Since the stress per square inch is to be 8,000 pounds, the total cross-sectional area of the bolts, that is, the whole area which has to resist the shearing force, is found by Rule 51, and is equal to

$$\frac{41291.68}{8{,}000} = 5.16 \text{ square inches.}$$

But our example requires that three bolts shall resist the shearing force, and since the bolts are subjected to a double shearing stress, the total area which has to resist the shearing force will be equal to six times the cross-sectional area of one bolt; hence we have

$$\frac{5.16}{6} = .86 \text{ square inch,}$$

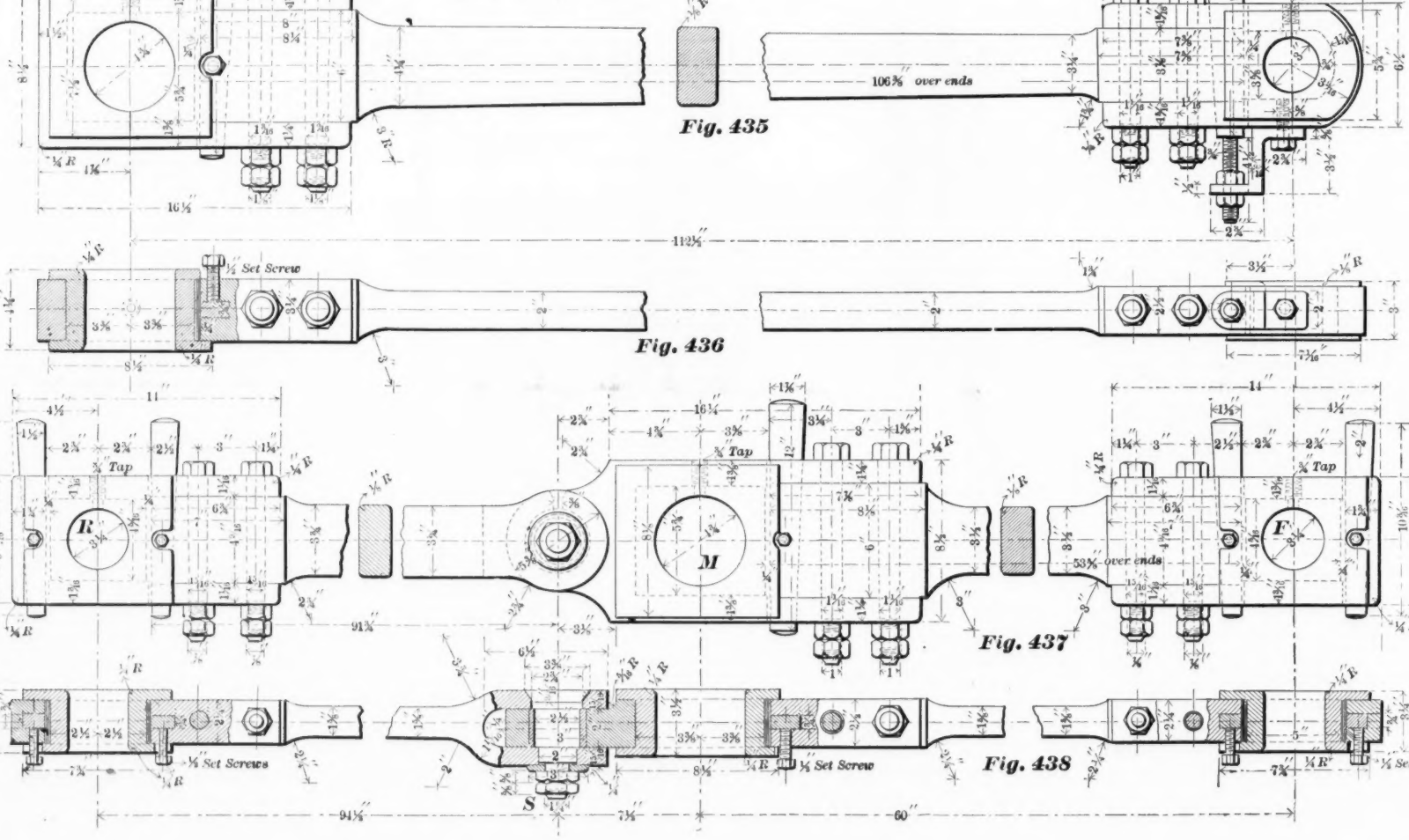
which is the cross-sectional area of one bolt. The diameter of a circle whose area is .86 inch is nearly equal to $1\frac{1}{16}$ inch; consequently the diameters of the bolts should be $1\frac{1}{16}$ inch.

Figs. 435, 436 represent a main rod, and Figs. 437, 438 represent a side rod for a mogul engine, that is to say, a locomotive having six driving wheels and a pony, or two wheeled truck.

In these engines the side rods have to connect three pairs of driving wheels, and transmit motion to the front and rear pair. We have already seen that the design of the pedestal permits the driving axles to move up and down, so as to enable the driving wheels to adjust themselves to any unevenness of the track, consequently the centers of the axles will not always lie in a horizontal line. Under these conditions we cannot connect the three driving wheels on one side of the engine by a side rod in which the crank-pin bearings are held rigidly in line. Consequently the side rods in mogul engines are made in two pieces, forming a front and rear side rod for each side of the engine, as shown in Figs. 437, 438.

The front and rear side rods are connected by the pin *S*, which is placed at the back of the main pin *M*. As far as the working of the engine is concerned, the pin *S* could be placed in front of the main pin *M*; but for the sake of convenience it is always best to place it at the back of the main crank-pin, so that it will at no time be covered by the main rod, which, in nearly all mogul engines, is placed outside of the side rods. In fact, it often happens that, with the main rods placed outside of the side rods, the available space between the side and main rods will not be sufficient for the nuts on the pin *S*, and consequently this pin must be placed at the back of the main pin *M* as shown. The pin *S* should also be placed as near as possible to the main crank-pin, so as to reduce the stress, to which the strap around the main pin is subjected, to a minimum.

From the foregoing remarks we may conclude that in mogul engines the front side rods contain the bearings for the front crank-pin *F* and for the main crank-pin *M*; the rear side rod simply contains the bearing for the rear crank-pin *R*.



Smothered Invention.

BY J. P. TITCOMB.

The inaptitude of that class of minds from whom the best inventions often spring for the practical work of putting them upon a profitable market, is doubtless mainly responsible for the seeming caprice of fortune in such things. There is frequently a sort of spell in the dreamy make-up of the successful thinker that binds him to his ideal world, and indisposes him to take part in the every-day scramble for business ascendency. Through this preoccupation of thought and neglect of practical affairs, his precious brain products are often purloined, and the credit, as well as the money gain, drift into the possession of those whose sense of honor and justice is too rudimentary to trouble them—at least to any very appreciable extent. And should the defrauded originator, or his friends, make an attempt to claim said credit or material gain, there is as much chance of redress, or of general enlightenment as to facts, as in the case of the sufferer from attacks of miasmatic onslaught or atmospheric rigors. The breadth of conviction settled in the general belief as to the claims of the practical victor, and the extravagant admiration built thereon prove a hopeless barrier against the development of the actual data, however genuine or well-acknowledged the facts in their own sequestered locality. The safety of the thief is thoroughly assured in this irresponsible and massive public conviction.

Yet it must be granted that the original idea, whatever its brilliancy, is often made

more effective and available for the world's use by the very pirate hands to whom its application and proceeds fall, than perchance it might have been under the parent treatment.

Cases of this kind are not "smothered" in the sense of depriving the race of practical benefit. It is only the strangling of the individual's private rights and hopes. But another case came recently to the writer's ken, which could justly be entitled to the term heading these lines.

Some years ago an English mechanic was one day driving a screw, the shank of which breaking under the strain, led him to vow that he would invent a screw, by the use of which that common and annoying contingency would be avoided. He thereupon fashioned a wooden model of a screw and driver that manifestly met the need in all respects. But, true to the type of mind above mentioned, after satisfying himself with the mental effort, its practical furtherance was abandoned. A woman of practical tendency, to whom he was married awhile afterward, chanced upon this wooden model under a loose pile of neckties and other contents of a bureau drawer. Struck with the evident value of the principle involved, she urged him to secure a patent, which he presently did.

The screw had a peculiarly shaped slot of square action, diminishing to a point far down in the shank, and the screw-driver sent it home with irresistible force and certainty. He moreover made machinery for its manufacture, whereby the cost of production could be greatly lessened, the cutting and nicking being done at the same time, making it possible to dispense with much of the outlay of time and labor involved in the ordinary process. Still further saving was also possible as to material used, chilled metal of any desirable and available kind being equally serviceable for the screws.

These advantages, when brought to light, set the monopolists in the craft by the ears. The chief establishment in the place, whose proprietor was a member of Parliament, and of wide influence otherwise in the business world, had a thousand machines on his hands, turning out screws of the ordinary type, and, recognizing the inevitable loss accruing to his property if the new process should be set in motion, he bought the patent at a round sum from the inventor and laid the device in its grave, where it slumbers to this day.

The narrator of the incident—a nephew of the inventor in question—mentioned other cases, among them that of a youth employed in a printing house, who, having invented an article of marked utility, but which would involve the destruction of current machinery and methods, had his device taken off his hands by his employers, who released him from service, by the payment of a sum providing for a liberal education, which he is this day prosecuting, while his mechanical device, as in the other instance, reposes in its costly tomb.

It seemed at first thought, to the writer, that this smothering of ideas that could enrich the world in their peculiar province was grossly reprehensible. But subsequent reflection argued that the parties in such transaction, on the one hand protecting their private interests from upheaval, and, on the other hand, availing themselves of immediate pecuniary profits of their thought, had an undoubted right to the management of their own affairs, irrespective of the clamors of the progress-loving world outside. Principle in the abstract may be clear as the noonday sun, but conscience overlaid with ponderous material interests is not easily clarified.

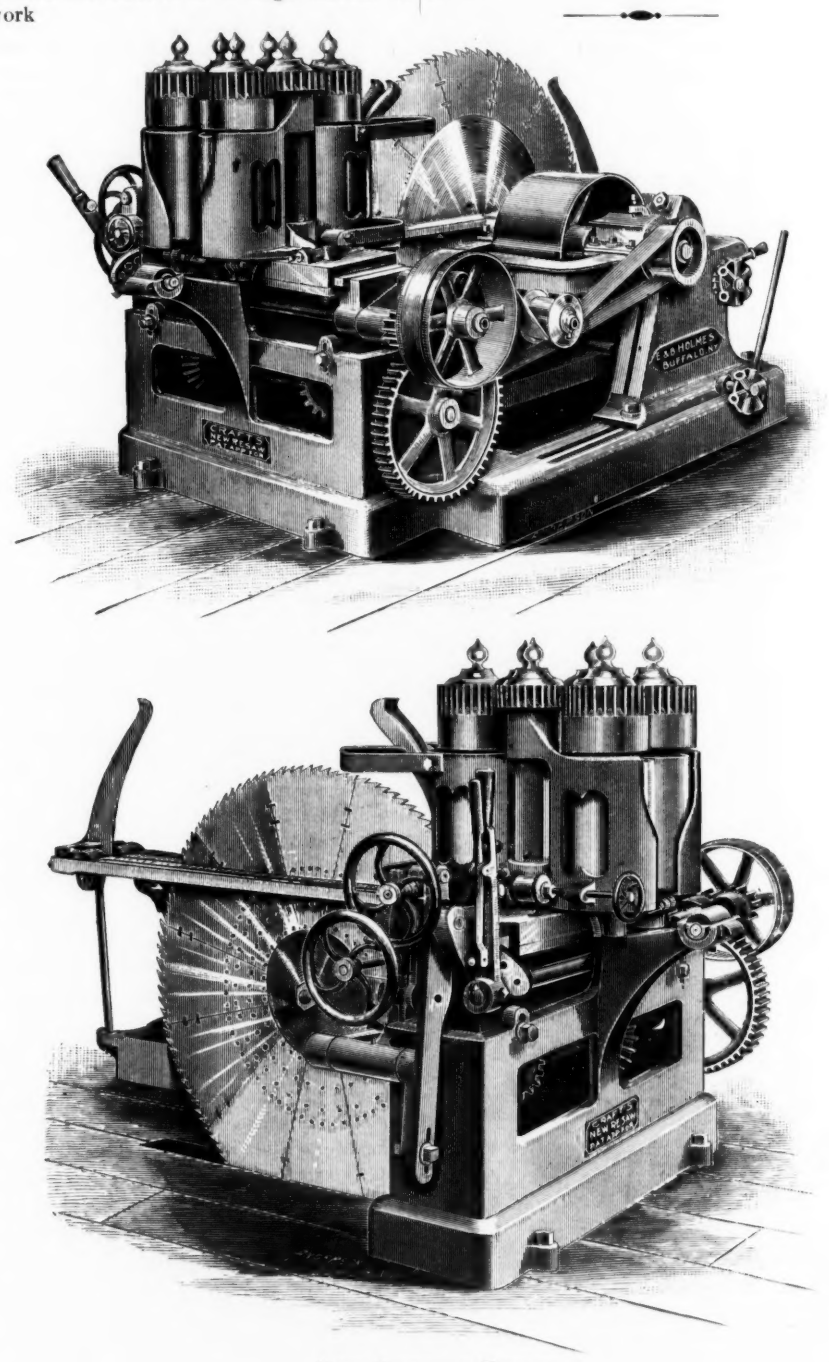
A "trust" in Nova Scotia proposes to secure legislation to prevent the launching of any more timber rafts. The last raft was a success, and that is why the trust is formed.

There is a reaction in Mexico in favor of American agricultural machinery. English machinery is, just now, at a discount in Mexico.

New Circular Resaw.

The engravings on this page represent two views of a machine for resawing lumber, built to use sectional saws and provided with the latest improved devices for this class of work. It consists of a heavy bed-plate to which the pedestal carrying the feed mechanism and rolls is bolted, and having planed ways with T slots along which the pedestal carrying the saw arbor can be moved by rack and pinion motion, and clamped in any desired position, to suit the size of saw used.

The makers have preferred to construct their machine for the use of sectional saws, on account of their lesser liability to buckle when heated by severe use, and on account of the fact that saws of very thin gauge can be used and made to do a large amount of work



NEW CIRCULAR RESAW.

Such saws require the use of large and heavy collars; a fact which makes them open to some objections, on account of the tendency to split the lumber ahead of the saw and leave "stub shorts" on the ends. To obviate this difficulty has been one of the objects kept in view in the designing of this machine. By the use of the hand wheels shown, the height of the saw may be adjusted to the work being done; sixteen inches of movement being provided for. By this means no more of the saw need project through the table than is necessary to reach through the lumber, which is being resawed; which, aside from the advantage mentioned, is claimed to give a better and more efficient action to the saw. To allow for variation in distance between the pulleys on account of this adjustment, the belt is made endless and kept tight, by a swing tightener, as shown.

The machine is provided with four heavy feed-rolls driven by powerful gearing. They also have a reverse motion, and are self-centering, but can be adjusted to enable the operator to cut parallel thicknesses from one side if necessary.

When it is desired to saw siding on the machine, the builders place two pulleys on the saw arbor, one 20″ diameter by 12½″ face, the other 10″ by 6½″ face, and proportionate pulleys are placed upon the countershaft. This provides for the proper speed for the siding saw.

Saws can be changed in five minutes, thus allowing of the use of two resaws, one of which may be taken off for filing or setting, and the other immediately substituted, with small loss of time.

The saw arbor is of steel three inches in diameter, fitted with improved patented journal boxes.

The builders are E. & B. Holmes, Buffalo, N. Y.

In a city not far from New York a "cheap" engineer was put in charge of some high-speed engines used for driving dynamos. A connecting-rod box got hot, and the babbitt began running out. The engineer, apparently thinking he had some new fangled stuffing-box to deal with, stopped the engine and screwed up the box bolts, remarking that he thought he could keep the stuff in. It is unnecessary to state the results. The engines are now wrecks, and have been set out of the way.

Variable Exhaust Damper.

The variable exhaust damper has been in use on a number of locomotives for about two years. It is a very simple device, formed at the base of the stack, takes the place of the ordinary smoke-stack saddle, and is arranged to admit air at the bottom of the stack at the will of the engineer. The principle of its action is simply to moderate the effect of the exhaust steam upon the fire.

The claim that, with the use of this damper, fuel can be saved, seems to be realized, as the following report from the Providence & Worcester R. R. will show:

PROVIDENCE & WORCESTER RAILROAD CO.'S COAL TEST

WITH ENGINE NO. 15, WITH H. A. LUTTGENS' PATENT REGISTER DAMPER, FROM APRIL 23d TO 30TH, 1888.

Rate.	Coal taken. Lbs	Mile per Car.	MILEAGE. Pass.	MILEAGE. Switch'g
April 23	6775	352	90	32
" 24	4699	308	90	31
" 25	4014	308	90	32
" 26	4440	352	90	34
" 27	4057	308	90	32
" 28	1346	352	90	29
	25331	1980	540	190

Total miles run, 730.
Miles run per ton of coal, 63.42.
Lbs. coal per mile, 34.68.
Lbs. coal per car mile, 12.79.

ENGINE NO. 15, WITHOUT DAMPER, FROM APRIL 30TH TO MAY 5TH, 1888.

Date.	Coal taken. Lbs	Mile per car.	MILEAGE. Pass.	MILEAGE. Switch'g
April 30	5862	352	90	33
May 1	6125	308	90	32
" 2	4477	308	90	35
" 3	4344	308	90	35
" 4	4610	308	90	32
" 5	3083	352	90	31
	28501	1936	540	198

Total miles run	738
Miles run to 1 ton of coal	56.94
Lbs. coal per mile	38.64
Lbs. coal per car mile	14.72
Lbs. coal per car mile, without damper	14.72
Lbs. coal per car mile, with damper	12.79
Difference	1.93

Another test, made on the New York, Susquehanna & Western R. R., some time previous to the date of the foregoing report, shows that during one week's trial without the damper 71,000 pounds of coal were used, and with the damper only 61,000 pounds of coal were used, the trains equal in each case.

Other advantages are claimed for this damper, among which we notice that there will be a perceptible decrease in the sparks thrown out from the stack when the damper is opened; also the draft upon the fire will be softened, so as to prevent the pulling of fire, which is of special use in starting.

This damper is the invention of H. A. Luttgens, Paterson, N. J.

LETTERS FROM PRACTICAL MEN.

Importance of Knowing How to Draw.

Editor American Machinist:

The knowledge of mechanical drawing, and the benefit to be derived therefrom, few can better appreciate than he who is constantly among men engaged in the different classes of manufacturing; and no one can be in a more favorable position to pass comments. Now, while Prof. Meyer has been doing his utmost to educate the rising generation of mechanics in the art, and the proprietors of the AMERICAN MACHINIST have been dealing out lessons every two weeks at the rate of five cents per lesson—each one of them being worth nearly as many dollars—no one seems to have endeavored to impress upon the minds of our young friends the great importance of embracing an opportunity, seldom, if ever, offered by any other mechanical publication in the whole country, if not in the civilized world.

A wealthy manufacturer once said to me that he would give ten thousand dollars cash down, and still be money in pocket, if he only understood mechanical drawing.

"Why," said he," it takes me longer to explain and make clear my ideas to our draftsman than it does for him to do the work." "If," he continued, "I had only learned to

draw when I was a young man, I should be much better fitted to carry on my business; but I did not think about it then, and now it is too late." Well, here is an illustration. We see before us a man who is the head of a large business, and who appreciates the fact that he is deficient in a study that would have been of infinite value to him throughout his whole business life. He is rich, to be sure—but he is well advanced in years, and he feels confident that, had he been proficient in mechanical drawing, instead of having been forced to rely upon the services of others, he might have retired from his cares long ago, and enjoyed some of the pleasures of this world at an earlier period of his life.

The superintendent of a factory employing a large number of men once undertook to explain to me a certain motion in a machine they contemplated building, and he proceeded to do so after this fashion: He procured a hammer, two lathe tools, a chisel, two pennies, and the cover of a dinner pail; after arranging them to his fancy he began to twist them this way and turn them that way, and wished me to suppose that such a thing represented such a part, and that something else represented another, when all at once he looked up and said, "See?" I was free to admit that I did not see. "Why," said he, "it's plain enough." I told him I could not brain it; and he probably thought I was a fool. I tore a leaf from my note-book, and with a pencil passed it to him, requesting that he would make a rough sketch—he couldn't do it to save him—and then the scene changed, and I thought *he* was the fool.

He was, however, very ready to acknowledge his inability to draw, and said the lack of such knowledge had often caused him much embarrassment, but he could generally understand a drawing when clearly explained. It was through his fine discipline, rather than mechanical skill, that he held his high position.

A number of years ago I became acquainted with a young man who was considered not only an extra fine workman, but quite an inventive genius as well, but a barrier seemed to stand between him and ultimate success. He was utterly deficient in descriptive power, and he could not draw; his only means of illustrating being by models, which were expensive. Mechanical drawings, he said, appeared to him like spider webs stretched across the paper, and had no meaning.

He had made some very valuable improvements in the shop, and his employer was so well pleased with his ability that he urged him to take lessons in mechanical drawing; and it was only after many protestations that he yielded. He proved an apt scholar, and in a surprisingly short time was able to draw anything—even his check for fifty thousand dollars. How did he do it? Why, bless you, he was able to put his ideas upon paper, and from paper into iron and steel; sold his inventions, invested the money in safe securities, and now he is well fixed for life—and a young man too.

I was once called as a witness in an important patent suit. There was a multitude of noted lawyers, judges, experts and so on retained by both sides. At a certain stage of the proceedings an argument arose between two of the lawyers respecting a particular feature of the invention in litigation, and one of them seemed to be getting the best of it, when the other remarked that if he had but a sketch or drawing of the part in question, he could soon convince the court that he was in the right.

There was only one man in that whole assembly who could draw from memory, and, by direction of the court, he proceeded, in free-hand, to illustrate the part—being perfectly familiar with the invention.

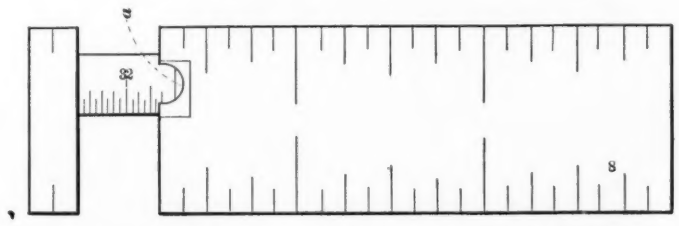
Upon inspection, the result proved so convincing that the argument ended at once. Modesty forbids my mentioning who made that drawing—but it won the case.

Now, the foregoing instances show some of the advantages and disadvantages of knowing and not knowing how to draw; and it is an easy matter for any one to decide which of the two is the most desirable.

I tell you, young men, learn to draw; provide yourselves with a few instruments and a board, and go at it; the outlay is but a trifle, and the returns may be large. You require no teacher, for the columns of the AMERICAN MACHINIST provide you the very best of instruction. If you have not the time to practice by day, then practice at night; though the daytime, with a northwest light, is what you really need. But two oil lamps, provided with suitable shades, and placed in positions to cast the least shadow, will do very well indeed.

But learn to draw, my young friend, for it will help you in your every-day work; and when you come to fill responsible positions you will be better fitted to direct the work of others. Learn to draw, if it is only for the sake of knowing how, for you can never tell what is in store for you, and too much knowledge never hurts any one. Learn to draw, and I believe you will see the day that you will thank Prof. Meyer for imparting to you some of his knowledge, and you will thank your humble servant for the suggestion.

T. P. FARMER.



Caliper Rule Kink.

Editor American Machinist:

Enclosed find sketch of a kink I have applied to a caliper rule. As now made, the body is beveled where it coincides with the beam. By observing sketch you will see I filed a circular notch *A* in the bevel, showing at least $\frac{1}{8}''$ of the graduations on the beam; it very much facilitates the reading, especially when it is almost to a large division. It is quickly and easily done. Try it.

C. E. CHANDLER.

Boston, Mass.

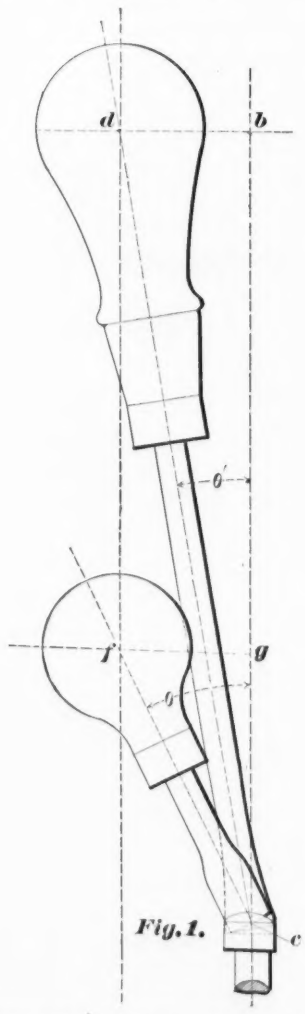


Fig. 1.

That Screw-Driver Question.

Editor American Machinist:

I have noted with some interest the many disquisitions and differences of opinion expressed on the supposed advantage of a long over a short screw-driver, and have been tempted several times to give what I regard as the true solution of what seems to be a generally admitted fact—that, everything else equal, a long screw-driver is more efficient than a shorter one. I have never seen the reasons advanced which I give below, and the explanation given in your issue of August 25, page 5, decided me to send you what seems to me to prove a very clear case in favor of the longer instrument.

In the operation of a screw-driver by hand, there is necessarily a certain lateral oscillation of the hand, and consequently of the handle end of the instrument. For a given lateral oscillation, the axis of the short screw-driver will make a greater angle with the axis of the screw than the longer one; and the greater this angle is, the less efficient the screw-driver becomes; first, from its greater liability to slip out of the slot—which, however, is scarcely in question here—and second, the real question, because, for any angle whatever, one component of the torsional effort of the hand is exerted in a vertical plane, and this component is clear loss of effort. In Fig. 1, a lateral movement of the handle end, equal to *d b* will give for the shorter tool, the angle *O*, and for the longer the angle O^1. In the two cases, if the lines *d c*, *f c* represent the total twisting effort, the line *d b* will in each case represent the ineffective component for the given angle, and the lines *b c*, *g c*, the effective component of this effort; and, as the ratio of *d b* to *g c* is greater than *d b* to *b c*, the shorter instrument is less efficient.

To illustrate this more completely, if we have a screw-head with a slot deep enough to resist the torsional effort exerted upon a screw-driver to rotate it about its own axis, placed as in Fig. 2, the whole effort to rotate the screw is lost by being all exerted in the vertical plane, the angle of the axis of the screw-driver with that of the screw becoming 90°; and, for any position for the instrument between the correct vertical one, *b c*, and that shown in Fig. 2, it will be efficient in the inverse proportion to the sine of the angle *O* or O^1 made by the instrument with the axis of the screw.

Your proposition that, with a long screw-driver, there may be an involuntary throwing of the axis out of line, and to this extent the instrument being made a lever, is scarcely tenable, because this tendency—as anyone who has had extended practice with such an instrument knows—is greater with the shorter instrument; on the same principle, I imagine, that a bicyclist can balance himself with greater ease on a high than on a low machine, or that it is more difficult to balance, in a vertical position, on the hand, a short than a long rod, the vertical pressure upon the screw-driver being represented in these cases by the action of gravity. Beside, for a given lateral movement of the hand or handle end of the instrument, the lever action of the short screw-driver would be the same as that of the longer, because of the greater angle made with the axis of the screw, the true lever being, in such a case, the sine *d b* of the angle O^1, or *f g* of the angle *O*. Again, this lever action could only be operative by the handle end describing a circle whose radius is *d b*, something entirely foreign to the action of the hand operating a screw-driver, and never approached, I think, in the slightest degree.

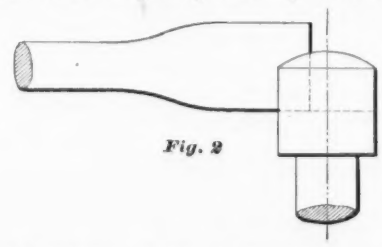


Fig. 2

J. T. HAWKINS.

Changing Situations.

Editor American Machinist:

Your article in Sept. 1st issue, entitled "Regarding Changes of Situations by Mechanics," is *good*. Of course the reason why I think it is good is because I thoroughly agree with it. It is so near what I have been preaching for a long time that it almost seems that I must have written it myself. Anyhow, I know of two or three persons who will accuse me of writing it, because these persons have called me a crank for holding such ideas. Of course a crank is some one we don't agree with. I have lately had a good position refused me *because I have worked in so many places*, and I have lately seen about five men who have worked for a certain company forty years, and grown old and bald-headed in the service, discharged on account of a change of management, and not one of these men knows which way to turn. Whether these men were competent to fill their positions or not does not enter into the question. I am not afraid to say to anybody that I consider the experience gained in the different shops in which I have worked to be my most valuable recommendation, and it is quite likely that I have not got through "changing" yet.

GREASER.

Design, Construction, Repairs and Management of Marine Steam Engines and Boilers.

BY W. H. HOFFMAN.

THIRTEENTH PAPER.

In marine engineering the stud bolt is almost universally adopted for securing the cylinder heads to the cylinder, as the chests' jackets and necessary receivers prevent the use of headed bolts. We will therefore assume that all cover bolts on our cylinders are studs; these being placed at the intervals best suited to the ultimate pressures they are called on to sustain.

I have frequently made a practice of counter-boring into all flanges where stud bolts are used, the size of the body or outside of the bolt, this counter-bore going to a depth of at least $\frac{1}{4}$ of an inch, with the object of preventing the bending stress on the bolt and its thread when screwing up the nut. I also make as many of the stud bolts of the same diameter as conditions will permit. For a triple expansion engine of the size we have proposed to design, we should make all of the cylinders and chest cover bolts of a uniform diameter; consequently all of the nuts about the cylinders will be alike, and one gauge of wrench will fit them all.

In the construction of the modern marine engine, the safety of a stud bolt must not only be calculated from the basis of a high intermittent tension, but also from the basis of undue torsional strains, caused by the inexperienced use of the wrenches. Our 26" high pressure cylinder head will be liable to repeated shocks of fifty tons, and if, by accident, excessive priming should take place while the engine is in rapid motion, double that pressure would be nearer the actual striking effect of the blow. To resist this, we fix our spacing of bolt centers at $5\frac{1}{4}''$, and this gives us eighteen bolts for each high-pressure cylinder head. Each bolt then will be required to withstand a continuous series of sudden shocks, amounting to a force of six tons. Now the area at the bottom of the thread of each bolt must be safely equal to this strain; supposing the bolt to be made of the best refined iron, having an ultimate tensile strength of 48,000 pounds to the square inch of section. Allowing a factor of 6, the safe tensile load on each bolt can be at the rate of 8,000 pounds per square inch. To warrant absolute safety, however, call the factor of safety 8, and as experience and experiment has shown that there must be nearly if not quite a full square inch of section at the bottom of the thread, in order to properly resist wrench torsion, we will fix on that section, for all our cylinder and chest cover stud bolts.

As I have before stated, the stud bolts on all three of the cylinders will be alike, and in order to have a diameter that will cover our full measure of cross-section, we will make all of these stud bolts $1\frac{3}{8}''$ in diameter on the outside.

One of the most important features in the arrangement of stud bolts is the drilling and tapping of the holes in the castings. No hole for a stud bolt should be drilled without a clamp drill-guide, or jig, as this device ensures a straight hole to begin with, and if the tap shank is made long enough, a tap-guide of the same description as the drill-guide can be used, thus giving perfect accuracy in the alignment of the studs.

The counter-boring for the body of the bolt is of course done by a cutter fitted to the drill shank, and is regulated as to depth by a suitable stop.

The latest novelty in marine engineering (the engines of the new English steamship City of New York) has a complete outfit of piston valves. In order to avoid an excess in diameter, and overhang of valve chest, the designer of these engines has subdivided the valve area, or, to illustrate, he has introduced four sets of small piston valves on the 113 inch low-pressure cylinder, instead of one set, while in the intermediate cylinder he has placed two sets of the same type of valve; the initial cylinder, however, being fitted with the usual style single piston valve.

We must take it for granted that the builders of the largest marine engines are still quite satisfied with the performance of the piston valve, but from appearances they have not, as a majority, taken kindly to the radial valve gears, for the reason that the latest examples of marine engineering skill, and the engines of the City of New York in particular, are fitted throughout with the old-fashioned link motion, and direct eccentric connections.

The real reasons for what may be properly termed a retrograde movement are not yet made known, but we can half guess them, as we all know that some of the late radial valve gears, as applied to marine engines, are simply appalling as to the quantity of detail in their design and construction. Rock shafts, radial rods, suspending bars, quadrant levers and tumbling trunnions, have lately been thrown into these designs with a perfect recklessness. Such valve motions are unreliable as to durability, and are positively dangerous to everyone in charge of the engines. The very intelligent class of men, engineers in the marine service, soon pass judgment on "trappy" valve gears, and when this judgment is in condemnation, such faulty machinery is sure to be removed. Every marine engineer is aware that there is always enough tribulation with steam machinery, at sea, without the introduction of any man-killing attachments. I think the designers of the radial valve gears have lately tried to do too much. The Brown and the Marshall gears were both good, and some of the previous designs of these radial motions have been giving very economic results for years. The marine experts, however, began some two or three years ago to make combinations of these old motions, and the more they combined them, the further they appeared to get from the ideal marine engine.

There could be but one result in the complication of these old designs, viz., failure in some degree, for the reason that the most rigid law in all the course of marine engineering study is *simplicity*, and thus it happens that a forest of valve rods, radial rods, rock shafts, and quadrants will not "fill the bill."

Yet I still believe that a simple and durable valve gear will be generally adopted in the marine service, on account of its many advantages in the distribution of the steam, and the handling of the engines.

It can be made simple and durable, but in designing it, the engineer must not expect to reach the perfection in distribution, of the four-valve automatic Corliss valve motion. Nor is there any call for such perfection, as the conditions of land and sea service are entirely different.

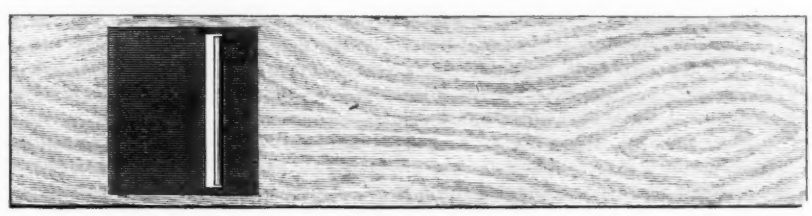
The design of the valve gear has much to do with the outside form of the steam cylinder, and as a rule, where this gear is complicated the chests and passages have a large overhang, and consequent long steam passages.

In order, therefore, to complete the design of our cylinders, I will in the next paper describe the valve motion I propose to adopt for our triple expansion marine engine.

Tuesday, the 21st was "iron worker's day" at the Cincinnati Exposition, and Mr. Geo. A. Gray was officer of the day. It was expected that large crowds of iron workers would be present, not only from Cincinnati, but from Hamilton, Dayton, Springfield, and other leading manufacturing points, six or seven hundred excursionists having made arrangements to come from Springfield. Most of this outpouring of iron workers was prevented by a copious down-pouring of rain. There was a large crowd in attendance, but nothing like what was expected. One of the incidents of the day was the presentation to Mr. Gray, by his employes, of a fine diamond pin.

The Gage Tool Company's Self-Setting Plane.

In our issue of Sept. 3, 1887, we illustrated and described this plane, but without allusion to the construction of the bottom. The cut shown herewith represents a view of the bottom. The iron part, which is plainly

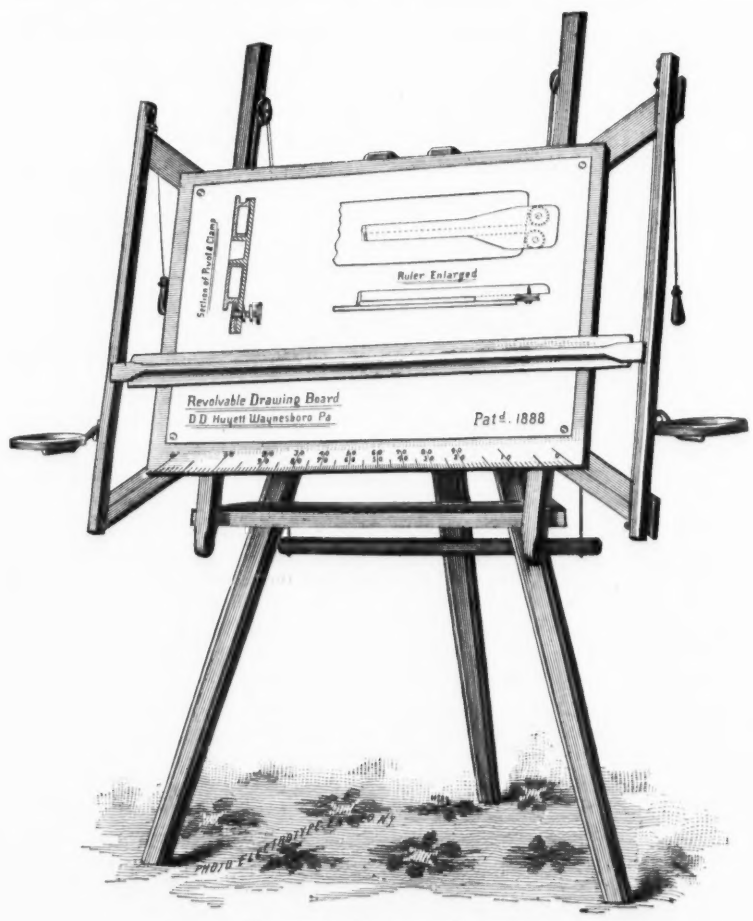


SELF-SETTING PLANE.

represented, forms a throat for the cutting blade and for the self-setting arrangement, and is adjustable in every way. It is firmly anchored to the wood by a steel rod passing through the plane from side to side, the construction, it is claimed, giving the solidity and durability of an iron plane. Manufactured by Gage Tool Co., Vineland, N. J.

Huyett's Drawing Board.

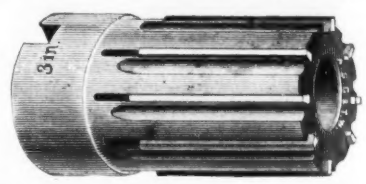
The accompanying cut represents an improvement in drawing boards, in which the board is pivotally connected to a supporting frame which carries a parallel ruler.



HUYETT'S DRAWING BOARD.

The parallelism of this ruler is maintained by the action of two cords (each of which is clamped near its ends to the supporting frame at points diagonally opposite) passing over the grooved pulleys—which are secured near the ends of the ruler—and extending lengthwise and crossing each other in a groove, in the handle-bar on top of ruler, which serves also to protect them.

The board is made of a thin slab of soft wood secured to a rectangular enclosing frame in such a manner as to allow it free expansion and contraction without affecting



SHELL REAMER WITH ADJUSTABLE BLADES.

the accuracy of the frame. One edge of this frame is provided with a scale of degrees from zero to 90°, running from right to left and from left to right. And the supporting frame has two guide lines diverging from the center at an angle corresponding to that of the two zero degree lines. Thus it will be readily seen that the board can be set at any degree of inclination to the ruler, and is held in position by a frictional clamp, to which any desired amount of tension can be given. The clamping device is so arranged as to permit of the board being quickly and easily removed (see drawing on board).

The supporting frame, together with board, ruler and side brackets for holding instruments, is mounted on a neatly designed easel, is counterbalanced, and is adjustable to allow working either in a sitting or standing position. The ruler is also counterweighted.

The leading feature of this board is that it can be set at any angle to the ruler quickly, and with a degree of accuracy not attainable by a small protractor. And when in any position it will be noticed that the whole board is within range of the ruler.

The principle of maintaining the parallelism of a ruler by the action of a cord has been in practical use sufficiently long to prove its entire practicability, and also that it has points of superiority over the T-square, being more easily manipulated (especially upon large boards), as well as more accurate.

The ruler can be used to a good advantage in section lining, by setting the board to the desired angle, which, at the same time, places the work in the most convenient position.

Being arranged so that the draftsman may either stand up or sit down, and being in a nearly vertical position, the tiresome and unhealthy stooping posture necessary in working over horizontal boards is avoided—a fact which will be duly appreciated, especially in making large drawings.

The easel and frames of these boards are usually made of ash (other hard woods, however, may be substituted by special contract), the board of soft white pine and the ruler of carefully selected cherry, put together in narrow strips to insure its remaining straight.

The size shown has a board 29×42 inches, but other sizes are built to order by the patentee and manufacturer, D. D. Huyett, Waynesboro, Franklin Co., Pa.

Shell Reamer With Adjustable Blades.

Every machinist knows that in order to construct machinery in the most economical manner, it is necessary that the holes in its different parts should be made with some degree of accuracy.

The solid reamer has no means of maintaining its original size, and is not standard, except when first used, losing somewhat of its size with every hole reamed.

The shell reamer shown above has the body made of steel, with eight or ten blades (according to size) inserted in the shank into dovetailed slots, the bottoms of which slots are inclined planes.

Now as these cutting edges will gradually lose their size in use, it is possible in this kind of a reamer to force the blades further into the body of the shell, and so restore the original size; this may be repeated until the cutters are driven to the upper end of the slots, when new cutters may be put in. These cutters are made of the best tool steel, are carefully hardened and made interchangeable.

This feature of restoring the size allows of an uniform difference to be maintained between the cutting edges and the shank, which shank, being ground two one-thousandths of an inch below the cutting edges, has a double purpose to fulfill, the grinding of the cutters, and as a limit of the amount of wear which will be permitted in the blades, so that holes below a known size cannot be made.

The cutters are tightly inserted, so as not to be changed by rough usage, or intentionally by the workman.

These shell reamers are being introduced by the American Standard Gauge and Tool Works, of Wilmington, Del., and will be furnished from two inches to three inches, with eight cutters, above three inches and up to five inches with ten cutters, straight or taper holes, as may be required.

A few years ago a man who should have talked of shipping pig-iron into Pennsylvania would have been regarded in much the same light as one who seriously proposed to engage in the famous business of "carrying coals to Newcastle;" and yet a few days ago the steamer City of Birmingham arrived at Philadelphia with 2,000 tons of pig-iron, a direct shipment from Birmingham, Ala.—this steamer, together with another one building, being designed especially for this trade. Thus a new factor is introduced into the iron trade, the ultimate effect of which it is difficult to foretell.

If the project of building an international railway some 2,000 miles long, in South America, is carried out, it will open up a large country to trade. The railway would traverse the principal South American States, and the need of such a road is said to be fully appreciated in these States.

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☞ *Every correspondent, in order to insure attention, should give his full name and address, not for publication, but as a guarantee of good faith.*

☞ *We are not engaged in procuring patent rights, or in selling machinery, nor have we any pet scheme to advance, or hobby to ride.*

☞ *We invite correspondence from practical machinists, engineers, inventors, draftsmen, and all those specially interested in the occupations we represent, on subjects pertaining to machinery.*

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Cleanliness.

A young friend of the writer's, who has recently commenced an apprenticeship to the machinist's trade, and has begun by working in the shop without overalls or other protection to his clothing, and going through the streets to his home without first washing from his hands and face the dirt which is a necessary accompaniment of work in a country jobbing shop, received some advice upon the subject from one who had been through the experience, which might prove beneficial to some of our young readers just commencing the same course, and who have started out with the mistaken idea that a machinist, a blacksmith, or a moulder, is necessarily a dirty fellow, and that dirt and general slovenliness, both in and out of the shop, is a necessary accompaniment to such occupations.

Of course no one can work in a machine shop without getting some dirt upon his person and clothing, and on some kinds of work and in some shops he will get a good deal of it, but by all means it should be left where it belongs—in the shop.

No greater mistake can be made by any young man, than to suppose that, simply because he is to be a machinist, he must, therefore, be resigned to walk through the streets all his life looking like a chimney sweep. In the shop, it is often necessary to have the hands blacked with a mixture of cast-iron dust, oil and miscellaneous dirt, but this condition, being the necessary result of honest and useful work, is no disgrace, but rather to the contrary. But that does not make dirt desirable in itself, and since, upon the street or at home, there is no necessity for it, there is no honor in wearing it there. While there are probably some exceptions to the rule, yet it can generally be said that the mechanic who has not sufficient pride or interest in his personal appearance to prevent him from walking through the streets to his home in a suit of clothes which have seen six months' service in the shop, without the protection of overalls or apron, and with the black dirt of the shop all over them, as well as his hands and face, cannot be expected to take much interest in his work, and will always be one of those who are perpetually complaining that there is "no show for a workingman."

It is far too common to hear mechanics complain that they have no social opportunities, that there are persons who despise them and refuse to notice them on the street or elsewhere "because they are mechanics." It is a mistake; no one whose society or good opinion you need care the least for will refuse to associate with you for any such reason. Almost any man can, if he chooses, associate with the best and highest society, without regard to his occupation, so long as it is honorable and he, in other respects, conforms to the usages and requirements of such society. Of course we are not unaware that there is a certain society, especially in the larger cities, whose sole basis for the estimation of character and fitness for social recognition is the possession of wealth, and the ability and disposition to make a display of wealth, and that such people usually assume to be at the top of the social pyramid. These people undoubtedly do despise mechanics and workingmen, simply because they are workingmen, and without regard to intelligence, moral character or general decency. The reason for this is plain, and consists in the simple fact that, if recognition in their particular society were based upon learning, intelligence, moral character, the accomplishment of anything useful, or in fact upon anything else than the mere possession of wealth, most of them would be unable to keep their positions, and it is therefore in pure self-defense that the one qualification required by them is the possession of wealth.

No mechanic, or any one else who amounts to anything, need care for admission into such society; but the members of what is really the best society in any community will be governed in their choice of associates by the personal worth, intelligence and moral character of the person seeking their society, and, in forming their opinions upon these points, will undoubtedly and unavoidably be influenced by the appearance of cleanliness and general decency, or otherwise, of the man; and if, judging partly or perhaps chiefly from this, they reject his society, it will not be at all because he is a mechanic, but because he shows that he has not sufficient respect for himself to keep clean. He might keep himself equally dirty by wallowing in the gutter occasionally, or by other means, and he would be equally despised, even though he were no mechanic at all. A chronic condition of uncleanliness, of clothing, person, mouth, or mind, is not a necessary accompaniment of a mechanical occupation. There are plenty of mechanics who know this, but there are others who would do well to ponder upon it, and to act and appear and talk as though they respected themselves, and all others worthy of respect, and then see if they fail to command respect simply because they are mechanics.

And it is a mistake to suppose that this is a matter of no importance; it is of the greatest importance, and has much to do with deciding the whole future course of any young man.

A mechanic who is neat and cleanly is the better mechanic for being so, and will the more quickly receive recognition of his abilities as a mechanic, and of his worth as a man and as a member of society, all of which are the things which go to make up real success in life. Chordal has well said in these columns that "a workman who is dirty and slouchy and down-at-the-heel all over as he leaves the shop, is the same while in the shop, and the stuff he sells for the price of labor is not generally extra super. The finest and cheapest work done in this country is done by high-priced men, who know a cuff from a collar, and the coarsest and most expensive work is done by men who have no soul above clothes which won't show dirt."

He might have added that, among the former kind of men, those who choose to do so will be found occupying social positions in the communities in which they live, which leave nothing to be desired in that respect. Chordal, like the present writer, is himself a machinist, and in writing upon this subject did so with the most profound respect for mechanics as such, and with nothing but the best of feelings toward them.

In our issue of August 11, among the manufacturing notes was an item taken from the *Telegram-Herald* of Grand Rapids, Mich., describing a new carving machine, the spindles of which revolved 14,500 times per minute and were of "such fine workmanship that they were made in a watch factory, with watchmaker's tools." A few days ago an AMERICAN MACHINIST man happened into the "watch factory" where they were made, and saw the lathe upon which they were turned. It is a watch tool maker's lathe, but is in the machine shop of the Springfield Machine Tool Company, at Springfield, Ohio.

Prof. Atwater on the Doctrine of Malthus.

Prof. W. O. Atwater, of Middletown, Conn., whose name has become familiar to many through his series of popular papers on the Chemistry of Foods in the *Century Magazine*, has done the cause of humanity a valuable service by attacking the doctrine of Malthus in a paper read at the recent meeting of the American Association for the Advancement of Science, at Cleveland, Ohio.

Judging from an abstract of his paper published in one of the Cleveland dailies, his argument was chiefly to show that there need not be wide-spread starvation of the inhabitants of the earth on account of the rapidity of the growth of population beyond the growth of the means of subsistence, because the science of chemistry shows that there are means as yet unused, by which the production of food can be augmented beyond anything we at present conceive of.

The information is interesting, and all lovers of humanity should hail it, as well as every other able attack upon this infamous doctrine, with rejoicing.

But the fact is, that one need not be a chemist to perceive that the Malthusian doctrine is without foundation in truth or natural law, and that its only function is to furnish an apparent excuse and justification for the infliction of wholly unnecessary deprivation and suffering. It is only necessary to read the history of nations, and to reflect upon the vast areas capable of producing food and other necessities of life which have not been put into service at all, to see that the principles enunciated by Malthus never have in the past, do not now, and in all human probability never will have, any appreciable effect upon social problems, except as they have a tendency to blind men's perceptions and blunt their sympathies.

Literary Notes.

We have received the July edition of the *National Car and Locomotive Builder Supplement*. It contains 128 pages, mostly advertisements of railroad tools and supplies. It also contains a list of the street railroads in the United States, Mexico and South America, and a list of manufacturers of locomotives, cars, and their principal parts. A copy is sent gratuitously to every one whose name appears in it; also to the principal railroad officials in the United States and Canada. It is published by John N. Reynolds, Morse Building, 140 Nassau street, New York.

QUESTIONS AND ANSWERS.

Under this head we propose to answer questions sent us, pertaining to our specialty, correctly, and according to common-sense methods.

Every question, to insure any attention, must invariably be accompanied by the writer's name and address. If so requested, neither name, correct initials nor location will be published.

(410) F. S. C., Cambridge, Mass., asks: Will you please inform me as to the dimensions of the American standard 11-16 hexagonal head-bolt finished, number of threads per inch, size of head, diameter at root of thread, and width of top and bottom of thread in decimals of an inch? *A.*—Number of threads per inch, 11; size of head from side to side, 11-16 inch; thickness of head, 17-32 inch; diameter at root of thread, .5695 inch; width of top and bottom of thread, .01136 inch.

(411) H. D., South Bethlehem, Pa., in Question 375, in our issue of Aug. 11, asks: Is there another design or pattern of the steam whistle besides the round one? To this question we answered: "Not that we are aware of." Since then a correspondent has sent us a rough, incomplete sketch of a square whistle, which, he says, was patented some five years ago by J. B. Barnes, now superintendent of motive power on the Wabash Railroad. He also states that these whistles were in use on the Wabash Railroad in 1884, giving good satisfaction

(412) O. W. P., Waltham, Mass., asks: What number of the AMERICAN MACHINIST explains or answers the cannon-ball problem like the following: Suppose a cannon to be mounted on a platform car and pointing back to the rear of the car, said car to be running at a greater velocity than the cannon-ball would have if fired from the same gun while standing still; say the car is moving westward and the gun is fired at a certain point, will the ball fall east or west of the given point? *A.*—There is no number of the paper which answers this specific question, but in the issue of April 21, 1888, you will find a similar question answered, and in the issue of June 2, 1888, p 5, you will find the principle governing the question more fully explained. In direct answer to your question, the ball under the given conditions will fall west of the firing point, the distance depending upon the amount of momentum imparted to the ball by the motion of the train, *in excess* of that which would be imparted to it by the explosive force of the powder if the cannon were discharged while standing still.

(413) C. H. W., Norwich, Conn., writes: I read in the Complete Practical Machinist, by J. Rose, that a rivet ¼ inch diameter should be used for outside calipers intended to measure up to seven inches. Then in Modern Machine Shop Practice, by the same author, it is stated that the joint should be 1¼ inch diameter for every 6 inches of leg. What size rivet or width of leg do you suggest for different lengths of legs, for plain calipers, outside and inside? *A.*—We are inclined to think that suggesting such sizes would be a work of supererogation; there is usually so little actual wear upon the joints of calipers, that it makes little difference as to the durability of the joint within reasonable limits. We should make the width of the leg at the top of such a proportion as would look well, make the washers the same size, and the rivet about ⅛ the size of the washer. A pair of inside calipers made by the writer, which look well and have proven very useful, have legs 4 inches long, ½ inch wide at the top, and have a 3-16 inch rivet. This is perhaps as good a proportion as any, and yet not better than some others; it is largely a matter of taste.

(414) J. B., New York, writes: 1. Suppose two pulleys, one 12 inches and the other 24 inches diameter; will the 24-inch one drive the 12-inch twice its own speed? *A.*—If they are friction pulleys running in contact without slip, it will. If they are at a distance from each other, and the driving is done through the medium of a belt, then the small pulley will be driven at something less than twice the speed of the large one. In making the calculation of the speeds an amount equal to the thickness of the belt should be added to the diameter of both pulleys. 2. Please let me know of a good book on the law of movable pulleys, with rules and examples on that point. *A.*—We know of no book on the subject, though almost any elementary book on mechanics will give you all the information needed. 3. I would like to know the consumption of coal per hour per horse-power for average condensing engines, also the same for non-condensing engines. *A.*—This depends upon many different conditions, such as size and construction of engine, etc., and it is impossible to give the average performance; but for a 100 horse-power engine 2¼ pounds would be a good performance for a condensing engine, and 3 or 3¼ pounds for a non-condensing one.

(415) W. B., Lewiston, Me., asks: Would you kindly give us the rule that tank builders use for placing the hoops or straps in proportionate position on the large water tanks for furnishing water to engines? They are placed closer together from the middle to the bottom than from the middle to the top, evidently on account of the greater pressure below the middle. *A.*—The distances between the hoops should be such that none of them will be subjected to a greater stress, due to the pressure of the water, than about 10,000 pounds per square inch of cross-section through the weakest part of the hoop; that is, through a section through the rivet holes. Since the lower hoops are subjected to the greatest stress, it is only necessary to find the distances between the lower hoops, and then increase the distances so that the two upper ones will be 7 or 8 inches further apart than the lower ones. John C. Trautwine, in his Civil Engineers' Pocket-Book, says: "One of 20 feet diameter and 12 feet deep may have 9 hoops of good iron, placed several inches nearer together at the bottom of the tank than at the top. Their width 3 inches; thickness of the lower two, ¼ inch; thence gradually diminished until the top one is but half as thick. The lower two are driven close together. These dimensions will allow for the rivet-holes for riveting together the overlapping ends; and for a moderate strain in driving the hoops firmly into place. Three rivets of ⅛ inch diameter and 3 inches apart, in line, are sufficient for a joint of a lower hoop; one of 34 feet diameter 17 feet deep may have 12 hoops; the lower ones 4 inches by ⅛, with three ¾-inch rivets to a lower hoop joint.

(416) C. E. C., Fond du Lac, Wis., writes: Is there any better book published on the steam engine, suitable for draftsmen and designers, than that by Arthur Rigg? If so, please give name. *A.*—There are other books published, treating on the steam engine, but whether these books will suit you better than the one you name we do not know. Good draftsmen and designers supply themselves with more than one book treating on the steam engine. Besides these books, good draftsmen have a technical education, either obtained in schools, or at home during leisure hours, which will enable them, in many cases, to make their own rules, and also to understand the principles upon which the rules given in books treating on steam engineering are based, so that no rules will be followed blindly. On the whole, then, it may be said that draftsmen require a great many books treating on various subjects, and these books must be thoroughly studied, otherwise they cannot design steam engines with success. 2. Is there a book published treating on the Corliss engine? *A.*—See answer to Question 378, in our issue of Aug. 11, 1888. 3. Give size of ports and point of cut-off for a slide valve engine 24" x 30"; 120 revolutions. Also give amount of lap. *A.*—The piston speed of this engine is 600 feet per minute. For this speed the area of the steam ports should not be less than 1-10 of the piston area; some engine builders make the steam port area equal to 1-9 the area of the piston. The area of the piston is 452.39 square inches. Adopting 1-10 of the area of the piston for the steam port area, we have 45.23 square inches for steam port area. The ratio between the width and length of the steam port is arbitrary. Assuming that the length of the steam port is 20 inches, then the width will be 2.25 inches. Assuming the length to be 22 inches, then the width must be 2.05 inches. The sizes of steam ports for any stationary engine, in which the steam ports also act as exhaust port, can be determined by the same rules as used for determining the sizes of the steam ports for locomotive cylinders given in the AMERICAN MACHINIST, Sept. 5, 1885. If now it is decided that the steam port shall be 20 inches x 2¼ inches, we find that, according to the article referred to, the width of the exhaust port should not be less than 4½ inches when the following lap is adopted. Assuming that the engine is to cut off at 24 inches of its stroke, we find by the simple graphic method given in an article on Modern Locomotive Construction, AMERICAN MACHINIST, Nov. 21, 1885, that the lap will be equal to 2 inches, and the travel of valve 8¾ inches. If the steam ports are made 22 inches long and 2.05 wide, the lap and travel of the valve will be a little less, and is determined by the same method. In a similar manner the suitable amount of lap for any point of cut-off can be found.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Wednesday for the ensuing week's issue.

See Grant's Gear advt. on back page.

Link-Belting.

Send for Catalogue of Link-Belting.

Over 50,000,000 feet of Link-Belt in use.

Link-Belt Machinery Co., Chicago and N. Y.

See our new designed engine lathes in Cincinnati Centennial Exposition, Lodge, Davis & Co.

See our new designed drill presses in Cincinnati Centennial Exposition, Lodge, Davis & Co.

See our new designed shapers in Cincinnati Centennial Exposition, Lodge, Davis & Co.

See our new designed brass working tools in Cincinnati Centennial Exposition, Lodge, Davis & Co.

2,000 feet of space in Cincinnati Centennial Exposition, Lodge, Davis & Co.

See special adv't, page 16, Lodge, Davis & Co.

Shafting Straighteners. J. H. Wells, Tampa, Fla.

Steel Name Stamps, etc. J. B. Roney, Lynn, Mass.

Lamb Knitting Machine Co., Chicopee Falls, Mass.

Machine work and pattern making. Anderson Machine Works, Peekskill, N. Y.

The Improved Justice Hammer. Williams, White & Co., Moline, Ill., manufacturers.

The Best Upright Hammers run by belt are made by W. P. Duncan & Co., Bellefonte, Pa.

Light articles built to order by the American Sewing Machine Co., Philadelphia, Pa.

R. Dudgeon, 24 Columbia st., New York. Improved Hydraulic Jacks and Roller Tube Expanders.

Pattern and Brand Letters. Vanderburgh, Wells & Co., cor. Fulton and Dutch sts., New York.

"Swift" Sight-feed Lubricator; no glass tubes; simple, reliable. Swift Lub'r Co., Elmira, N. Y.

Davis Key-Seating Machines, kept in stock by Manning, Maxwell & Moore, 111 Liberty st., N. Y.

"How to Keep Boilers Clean." A book mailed free, by James E. Hotchkiss, 120 Liberty st., N. Y.

"Bradley's Power Hammers, the best in the world." 20 sizes. Bradley & Co., Syracuse, N. Y.

Drawings, mach. patterns and models. Inventors' ideas perfected. Valentine, 15 Alling st., Newark, N. J.

Selden Packing, for stuffing-box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N. Y.

Brown & Sharpe Mfg. Co. have a line of machinery with S. A. Smith, 23 S. Canal st., Chicago, Ill.

Patents—Whittlesey & Wright, 705 8th st., N. W., Washington, D.C. Send for pamphlet and references.

Ice and Refrigerating Machines, 124 built, and all successful. David Boyle, 521 Monroe st., Chicago, Ill.

For the latest improved Diamond Prospecting Drill, address the M. C. Bullock Mfg. Co., 138 Jackson st., Chicago, Ill.

Engine lathes, hand lathes, fine tools, files and supplies for machinists and other metal workers. Frasse & Co., 92 Park Row, N. Y.

Most sensitive and durable Damper Regulator made; works within one pound; send for circular. T. Kieley, 11 West 13th st., New York.

Special electric light for factories; large or small plants. Address The Waterhouse Electric and Manufacturing Co., Hartford, Conn.

Patent Attorney. R. G. DuBois, 916 F. st., Washington, D. C. Service at reasonable rates. Send for pamphlet containing list of references.

Split Pulleys at low prices, and of same strength and appearance as Whole Pulleys. Yocum & Son's Shafting Works, Drinker st., Philadelphia, Pa.

Machinists supplies, brass goods, m'f'rs supplies, polishing materials, all kinds wire, metals, etc., in any quantity. Jordan & Gottfried, 208 Canal st., N. Y.

Fine tools and supplies for machinists and other metalworkers. Get our prices before purchasing elsewhere. Montgomery & Co., 105 Fulton st., N. Y. City.

Curtis Pressure Regulators. Curtis Return Trap, Curtis Damper Regulator. See Sept. 1, p. 12. Send for circular No. 17. Curtis Reg. Co., Boston, Mass.

The Holly Manufacturing Company, of Lockport, N. Y., will send, on application, their pamphlet illustrating pumping machinery and reports of duty trials.

Upright drills, improved, sizes 21", 23", 25", 28", 32", 36" swing; finely made and great capacity: write for cuts and prices. Currier & Snyder, Worcester, Mass.

W. H. Hoffman, consulting engineer, 108 Liberty st., room 3, N. Y. Mechanical engineering in all its branches; working drawings for the transmission of power by steam, water, air and electricity.

Contract work of all kinds executed promptly and on reasonable terms. Parties wishing gray iron castings in large quantities can make money by corresponding with Rawson Mfg. Co., Hornellsville, N. Y.

Wanted—A mechanic in every shop in the world to act as agent. No interference with regular work; no capital required; free samples and good commission. Send for samples and particulars to F. N. Carter, 176 St. Clair st., Cleveland, O.

A system of easy lettering by J. H. Cromwell, giving 26 forms of alphabets. The space to be lettered being divided into squares; simple and effective. Price 50 cents. Calalogue of books for engineers free. E. & F. N. Spon, 12 Cortlandt st., N. Y.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator, and making all required calculations from the diagram; also the principles of economy in operating steam engines, and current practice in testing engines and boilers. Price $2, postpaid. Published by John Wiley & Sons, 15 Astor Place, New York.

"Binders" for the AMERICAN MACHINIST. Two styles, the "Common Sense," as heretofore sold by us, and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers, with full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUB'G CO., 96 Fulton st., New York.

The series of articles by J. G. A. Meyer, on "Practical Drawing," now running in the AMERICAN MACHINIST, should be closely followed by every student. They commenced with October 23, 1886 issue, and up to and including August 11, 1888 issue, 56 articles have been so far published. Copies containing these articles sent by mail to any part of this country or Canada at 5 cents each. AMERICAN MACHINIST PUBLISHING CO., 96 Fulton st., New York.

"Modern Locomotive Construction." By J. G. A. Meyer. The above series of articles, now running in the AMERICAN MACHINIST, are attracting the attention of railway mechanics all over the world. Commencing with the June 27, 1885 issue, 70 articles have thus far appeared up to and including the August 4, 1888 issue. Copies containing these articles sent by mail to any part of the U. S. or Canada at 5 cents each. AMERICAN MACHINIST PUBLISHING CO., 96 Fulton st., New York.

MANUFACTURES

L. Logan will build a lumber mill at Lake Charles, La.

A. G. Turner is building a new silk mill at Willimantic, Conn.

The Nonotuck Silk Company, Leeds, Mass., are enlarging their machine shop.

The Little Rock (Ark.) Chair Company contemplate building a new factory.

The Waters Manufacturing Company will build a foundry at Nashville, Tenn.

The Chicago Cold Bending and Coiling Pipe Company has been incorporated, with a capital of $150,000.

The Winfield Manufacturing Company has been organized, to make sheet metal goods at Warren, Ohio.

Sulzer & Vogt, Louisville, Ky., are building an addition to their machine and elevator works, 50 x 200 feet.

B. F. Thomas is interested in a company that will manufacture furniture, mattresses, etc., at Chattanooga, Tenn.

The Penn Bridge Works, of Beaver Falls, Pa., have orders ahead to keep all hands running busy for several months.

John Burgeson, New Sweden, Maine, contemplates putting a new engine in his lumber mill; he will also add considerably to the machinery in his mill.

The Atchison, Topeka and Santa Fe Railroad Company has purchased a tract of land in Chicago, Ill., upon which to erect shops to employ 1,500 men.

John Goodin, who manufactures steam and hot water heating outfits at St. Louis, Mo., has removed to his new shop. This is three stories, 84 x 105 feet.

The Nova Scotia Steel Company, New Glasgow, N. C., will change its name to the Nova Scotia Steel and Forge Company, and increase its capital stock to $1,000,000

The force of men employed at Witherow's Iron Works, New Castle, Pa., will be increased by about 100. The firm has large contracts for the erection of blast furnaces.

The Lewis Foundry and Machine Company, Pittsburgh, Pa., are building an enormous rotary "squeezer" for the Solar Iron Works, of the same city. It will be driven by a reversible engine.

The Sheboygan (Wis.) Chair Company expect to start up the works formerly known as the Sheboygan M'f'g Company. This will give employment to more than 600 men.

The American Nail Machine Company has finally definitely concluded to move from Ashtabula to Findlay, Ohio. The contract for their buildings at Findlay has been let, and the company will occupy them Nov. 1.

The large rolling mill and nail factory of Taggart & Co., at Northumberland, Pa., resumed operations recently, and will be placed on double turn as soon as the full force of employes can be secured. The mill has been idle for sixteen months.

New water-works, or improvement in existing works, are contemplated at Smith Centre, Kan.; Spartansburg, S. C.; Mobile, Ala.; Maryville, Cal.; San Buenaventura, Cal.; Wichita, Kan.; Greenfield, Ind.; Mazo Manie, Wis.; Columbus, Ind.

A company has been organized at Auburn, Maine, known as the Auburn Boot and Shoe Crimping Company, to manufacture a crimping machine, the invention of Walter Frost. At present the machines are being made at King & Loring's machine shop.

After a shut-down of five weeks for repairs, the Beaver Falls (Pa.) Steel Works have resumed operations in all departments except the melting department, which will resume operations Monday, the 27th inst. The repairs in this mill have been very thorough.

Struthers, Wells & Co., of Warren, Pa., have engaged in a new branch of business at their foundry and machine shops. It is the building of narrow gauge railroad locomotives, especially adapted to the lumbering business. The inventor is Mr. W. L. Sykes, of Benzinger, Pa., who has patented certain improvements that are said to cheapen the cost of construction materially.

Messrs. Cheney Brothers, the well-known silk manufacturers of South Manchester, Conn., are now putting in another battery of Harrison safety boilers, aggregating 480 horse-power; this makes a total of upwards of 2,200 horse-power of these boilers which this firm have purchased, and is their eighth order after having over twenty-one years' experience with them.

Tower & Lyon, of 95 Chambers street, New York, who bought out Melvin Stephens' business and stock of Stephens vises a year or so ago, have now completely sold out the vises bought of Mr. Stephens, and have put in their warerooms an entirely new stock of these vises from their own factory, in which they have largely increased their manufacturing facilities. We are in receipt of their latest catalogue, which is very fully illustrated, and shows a large variety of specialties made and sold by them. Amongst other things we note a level, arranged for "sighting" shafting.

The National Pipe Bending Company, New Haven, Conn., report very satisfactory orders during the past month. They have sold a large number of heaters, ranging from 50 to 1,000 horse-power. Their orders have been from all parts of the country, and from foreign countries. They have also had a fine run of business in making coils of iron pipe.

The Moore Manufacturing Company, Nos. 51 and 53 Franklin street, has been succeeded by the Moore Manufacturing and Foundry Company, of Milwaukee, Wis. The new company is erecting at Milwaukee an extensive plant for the manufacture of its well-known hardware specialties, including door hangers, vises, differential pulley blocks, etc. They expect to start up their new plant about October 15th next, and will soon be prepared to solicit contracts for light and medium gray iron castings, light machine work, forging and japanning. The high standard which the goods manufactured by the old company have attained, will, in every regard, be kept up by the new corporation. The Chicago office will continue at 51 Franklin street.—*The Industrial World.*

The following are among the recent sales of W. H. Warren, Worcester, Mass.: To Union Water Meter Company, Worcester, Mass., one radial drill, weight, 9,000 pounds, also the third shaper for brass work constructed so as to cut at the rate of 100 feet per minute, and a new design of two-spindle boring and drilling machine, the spindles working from each end of the machine at the same time; to the Atlantic Works, Boston, Mass., one radial drill; to the Rhode Island Locomotive Works, Providence, R. I., one radial drill; to the Brown & Sharpe M'f'g Co., Providence, R. I. the fourth radial drill, with order for the fifth; to the Lane Manufacturing Company, Montpelier, Vt., one radial drill; to Edward Kendall & Sons, Cambridgeport, Mass., one combined slotter and milling and drilling machine, as illustrated in our issue of August 11.

An immense silverware factory is being built at Providence, R. I., by the Gorham manufactory. The foundations will be 4,350 feet, almost one mile in length. The main building will be 419 by 256 feet, 44 feet wide and three stories in height. The next two will be 419 by 225 feet, same width and height. The building in which the preparatory work will be done will be one story high and 225 x 80 feet, with extra heavy foundations. The exhibition room will be 200 x 65 feet and two stories. There will be a building 50 x 50, three stories, and two 50 x 50, one story; boiler room, 68 x 73; wood-working and turning shop, 101 x 48, two stories; foundry, one story, 63 x 43. The vault for the storage of the most valuable goods and solid silverware will be 20 x 18 feet, and three stories high. Blacksmith shop, 50 x 50, one story; chimney 120 feet high, and tower 85 feet high with a clock. The buildings will be built of brick, with granite trimmings.

By the terms of the contract with the company which is to furnish water to the city of Greenville, Tex., the company is to make a lake one mile northwest of the city, to hold 300,000,000 gallons of water, to furnish a steel stand pipe 130 feet high and 15 feet in diameter, the system to supply 2,000,000 gallons of water daily, the engine and pump houses to be of substantial brick. There are to be one mile of ten-inch pipe, four miles of six-inch pipe, and enough smaller pipe to supply all parts of the city. Sixty hydrants are to be furnished for fire and other purposes, to be located by the City Council. The rate for water for private parties is not to exceed the lawful rate for Dallas and other Texas cities. The franchise has fixed the maximum rate to be charged. The system is to cost about $85,000, is to be owned and operated by the company, and the city of Greenville is to pay an annual rental of $5,000. The company is composed of John Harrison, F. B. Nichols and Thomas Howard, of St. Louis, and T. H. King, J. H. Cook and J. D. Lasater, of this city. Work must begin within sixty days, and the system is to be completed inside of six months.

The Hussey Re-heater and Steam Plant Improvement Company, of New York, are looking for a location for a manufacturing plant. The Carthage *Tribune* says of this concern, which has been looking at the facilities offered at Carthage: The business of this company has grown to large proportions. Heretofore the work has been let by them on contract to outside parties for the manufacture of their machinery. The growth in their business has been such as to make it an object for them to manufacture their own goods, and with this in view Mr. Brewer is now seeking a desirable place at which to locate, erect shops and put in a plant. The capital stock of this company is $100,000, and at the start from thirty to fifty skilled mechanics will be employed. This number will be increased as rapidly as the demand for their machinery will warrant. It seems to us that we could afford to place such an institution on the "free list," so far as taxes are concerned. It manufactures three appliances for economy in steam—improved method for compound engines, compound automatic water heater, and the Hussey re-heater. Mr. Brewer [the general manager] after a visit to several other towns, will return to New York, when the company will consider our excellent advantages and determine whether the works will be located here or elsewhere. We sincerely hope that they will see it for their interests to locate in Carthage.

Machinists' Supplies and Iron.

NEW YORK, Aug. 30, 1888.

The general condition of trade is much the same as at our last report. No important changes in quotations are noted, though Southern brands are now available, and are in competition with Northern brands. We quote Standard Lehigh and North River brands, $17.50 to $18 for No. 1 X Foundry, $16.50 to $17 for No. 2, and $15 to $16 for Grey Forge.

Scotch Pig—We quote Coltness, $19.75 to $20; Glengarnock, $19.25 to $19.50; Eglinton, $17.50 to $17.75; Langloan, $19 to $19.50; Dalmellington, $18 to $18.25; and Clyde, $19 to $19.50.

Copper—Chili bars have further advanced in London recently, which has caused increased firmness in this market. Prices for spot are 16.95 to 17c.

Tin—We quote jobbing lots of Banca, 21½c.; Straits and Malacca, 21⅛c.; Billiton, 21½c.; and Australian 21⅛c.

Spelter—Ordinary brands of Western 4.75 to 5c.; Choice, 5¼c.; Refined, 6¼ to 7¼c.; and Silesian, 5⅜ to 5½c.

✻WANTED✻

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Wednesday morning for the ensuing week's issue.

Wanted—Men to examine S. S. planes; see p. 11.

Mech'l draftsman and designer, has had practical shop exp., wants position. Box 20, AM. MACHINIST.

A mechanical draftsman wants to take charge of drawing office in a Western city. Address A. T. W., AMERICAN MACHINIST.

Wanted—Travelers for New England and Middle States, to handle mechanical goods; liberal commission. Box 17, AMERICAN MACHINIST.

Mechanical engineer and draftsman wants situation; experienced in marine, hydraulic and general engineering. A. B., AMERICAN MACHINIST.

Wanted—Brass pipe fitter on new locomotive work, and man for packets; state experience and wages expected. Address Box 19, AM. MACHINIST.

Young man, good machinist and tool maker, understands metal pattern and moulding mach. work, wants position West or South. W., AM. MACHINIST.

Young man who is competent machinist would like to hear of chance to invest say, $1,000, with services in a safe business; manufacturing preferred. Box 22, AMERICAN MACHINIST.

Wanted—To make arrangements with a good house to travel with steam goods, west or east; have had 13 years' experience; know the trade well. Address M., AMERICAN MACHINIST.

Wanted—Position as superintendent or manager; has had experience as machinist, foreman, superintendent and manager; is at present manager of m'f'g Co., but desires a change. S. W. J., AM. MACHINIST.

Man of thorough practical as well as theoretical training, wishes situation as superintendent in a good concern, where he can obtain in time interest in the business. Address Superintendent, care AMERICAN MACHINIST.

Wanted—Situation as foreman or workman of a brass foundry, with a firm who runs one or two men; a man with family and strictly temperate; a practical workman on all kinds of metals; can give best of references. Address Box 11, AMERICAN MACHINIST.

Wanted—Situation by a man who has had thirty years' experience in machinery business as superintendent and salesman; is at present superintendent of machine shop; will be open for engagement after Sept. 15; references furnished if desired. Address W. E., Post Office Box 38, Hoosick Falls, N. Y.

Wanted—Position as superintendent or foreman by a first-class foundry man; experienced in the use of pneumatic moulding machines and have a complete knowledge of modern foundry practice on all classes of work, also in the melting and mixing of iron, estimating on work, etc. Address Western, Box 1201, Pullman, Ill.

Wanted foundry foreman. A thoroughly reliable man who is capable of producing first-class work at minimum cost, in pulley and machine castings, heavy and light, can find steady employment at the highest wages with us; must produce proper and reliable recommendations, which will be thoroughly investigated. Todd Pulley & Shafting Works, East St. Louis, Ill.

Wanted—Foreman for boiler works, one who has had experience with marine and stationary work, also tank work; must read drawings, make estimates, lay out work and handle men and tools to full capacity; steady employment to proper party; only sober and industrious mechanics need apply; state references, age and experience. Address G. S. Wormer & Sons, Detroit, Mich.

Wanted—An experienced foundryman as assistant to superintendent of large foundry in the West, making heavy machinery castings in connection with a large manufacturing establishment; must have full knowledge of mixing various irons and moulding of heavy general castings. Applicant should give references and general history of applicant's experience. Address Box 21, AM. MACHINIST.

✢ MISCELLANEOUS WANTS. ✢

Advertisements will be inserted under this head at 35 cents per line, each insertion.

Crescent steel tube scrapers are unquestionably the best. Crescent Mfg. Co., Cleveland, Ohio.

Crescent boiler tube cutter, for setting new and removing old tubes. Crescent Mfg. Co., Cleveland, O.

August C. Christensen, 24 State st., N. Y., mechanical engineer and draftsman; 25 years' experience.

Light and fine machinery to order; Foot Lathe Catalogue for stamp. E. O. Chase, Newark, N. J.

D. J. Kelsey, M. E., designs machinery and iron structures; pat. drawings. 31 Ins. Bld., New Haven, Ct.

Correspondence solicited with parties having machine or foundry specialties to build. Honesdale Iron Works, Honesdale, Pa.

Wanted—To buy second-hand lathes, planers and shapers of all sizes; must be cheap and in good order. Fosdick & Plucker, 6th and Culvert Streets, Cincinnati O.

How to remove and prevent scale in steam boilers at a cost of ten cents a week. Send postal for circular to Pittsburgh Boiler Scale Resolvent Co. Pittsburgh, Pa.

Hardware, light machinery and models in brass, iron or steel made to order in small or large quantities. Catalogue of model supplies and tools free. Goodnow & Wightman, Boston, Mass.

For Sale—One second-hand Daniel's wood surface planer, all in good order and nearly new, 34 inch wide between uprights, 12 feet table, with 6 feet extension. The R. A. Belden Co., New Haven, Conn.

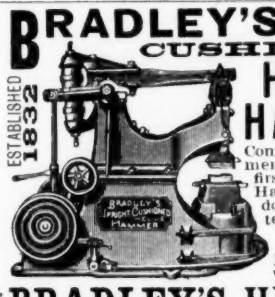
Wanted—Immediately, one second-hand iron ladle, eight thousand pounds capacity, in good condition. Address at once, stating price, and time of delivery, The Washington Architectural Iron and Bridge Works, 33rd & Water sts., Washington, D. C.

Ernest W. Naylor, consulting engineer, 149 Broadway, N. Y. Designer of the heaviest class of machinery used in the manufacture of iron and steel; hydraulic forging presses, etc.; armor plate presses, cranes and hoists of every description, and up to any size.

Special notice to pump manufacturers and general machine builders: Having obtained broad patents upon an improved form of vacuum air pump, I am desirous of entering into an arrangement for the manufacture of same, upon royalty or otherwise. The pump is adapted to college and electric light use, as well as for general pump purposes. Vacuum obtainable in moderate sizes equal to best school apparatus. Can be built as an air compressor and vacuumizer in one with efficiency, and is not limited as regards size. Manufacturers please not pass over this notice, but address for further information, A. B. Worth, Greenport, L. I., N. Y.

BRADLEY'S UPRIGHT CUSHIONED HELVE HAMMER

ESTABLISHED 1832



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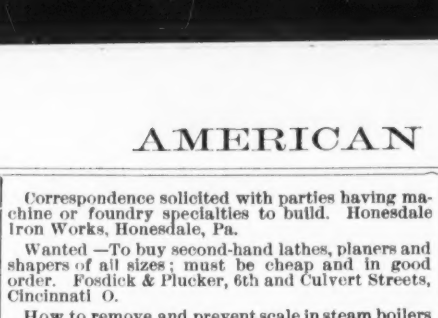

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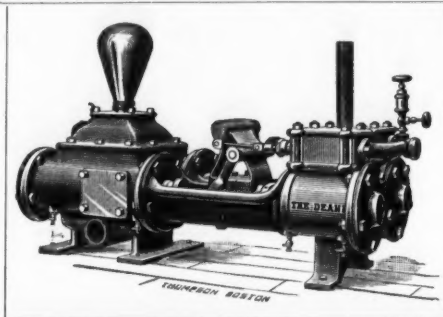

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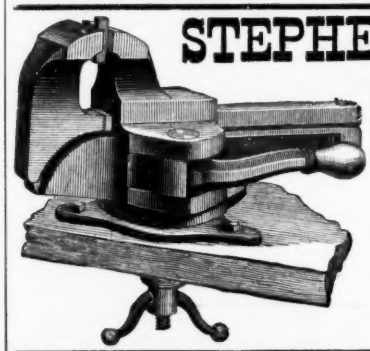

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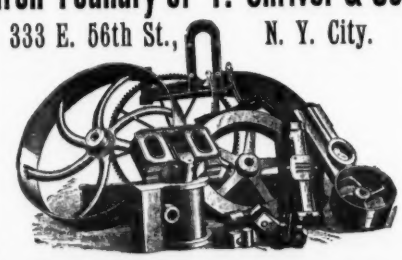

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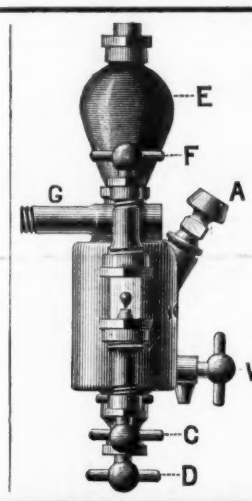

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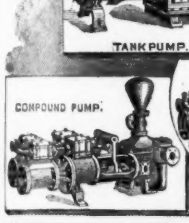

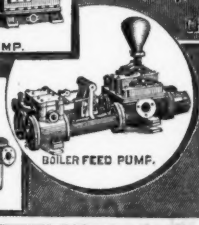

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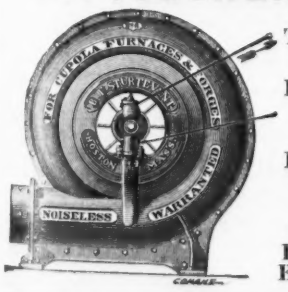

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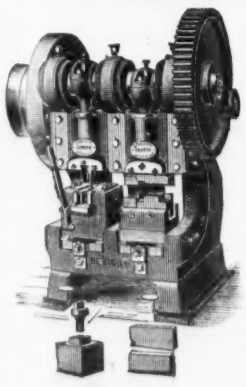

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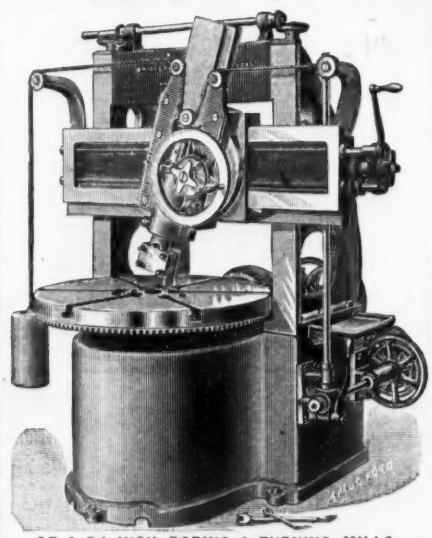

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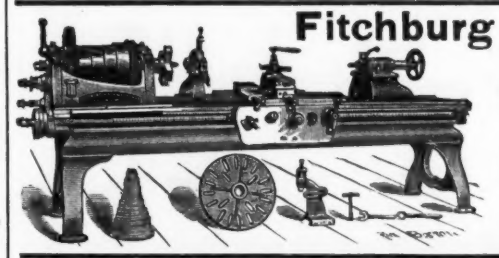

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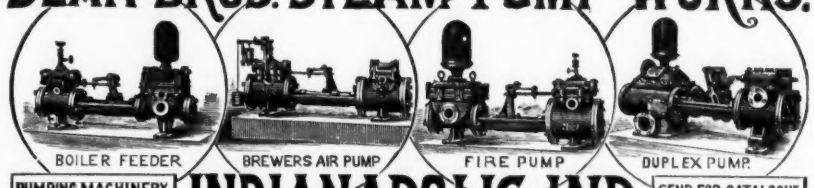

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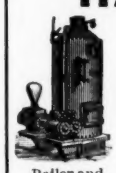

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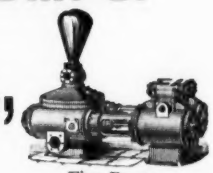

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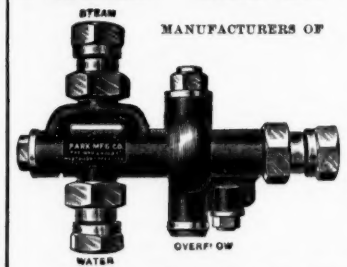

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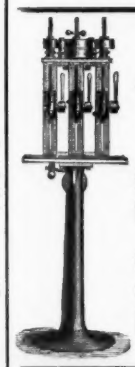

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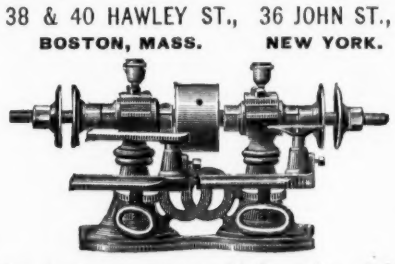

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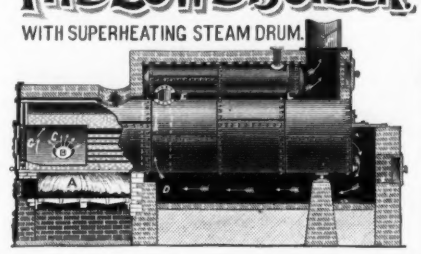

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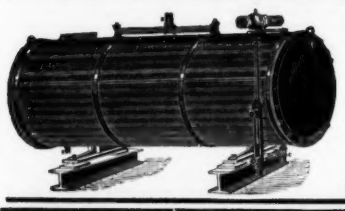

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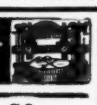

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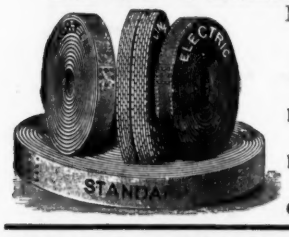

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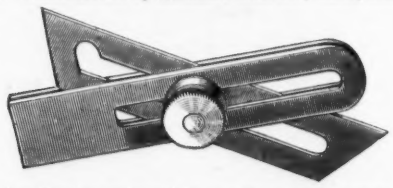

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COIL-BOILERS FOR THE UNITED STATES NAVY.—NAVY DEPARTMENT, Washington, D. C., August 2, 1888.—The Navy Department, having in view the possible decrease in weight of machinery in vessels of war by the use of tubulous, sectional or coil-boilers, has determined to adopt such boilers, if suitable can be found, for a portion of the steam-power of one or more of the vessels about to be built. To this end, manufacturers who wish to offer such boilers for use by the Department are hereby invited to furnish plans of the same, adapted to an armored coast-defense vessel, on or before September 15, 1888. Plans must be accompanied by certificates that boilers of the same make are or have been in successful use at sea or on shore. Plans showing the space in the vessel available for boilers, particulars of the duty required, and other information, may be obtained upon application to the Bureau of Steam Engineering. The boiler which appears to the Department, after investigation, to be the best for the purpose, taking into account the evaporative efficiency, the dryness of the steam, the weight of the boiler, the weight of the water contained, the accessibility for repairs, the ease of making repairs, the simplicity and interchangeability of the parts, the space occupied, the ease of firing and of regulating the feed, the suitability for working in battery, the capability of long-continued steaming without cleaning, and the durability, will be adopted in the coast-defense vessel above mentioned, provided that the price, which must be stated when the plans are submitted, is satisfactory to the Navy Department. Such boilers as appear to possess merit will be tested by the Navy Department, if the manufacturers so desire, to determine which is the more suitable for the purpose. Manufacturers who wish their boilers to be tested must furnish a boiler of the type of one of those proposed for the vessel and prepare it for test, either at their own works or at such place as may be arranged with the Department. The expense of the test of the accepted boiler will be borne by the Navy Department, and the cost of the fuel used in the test of the second best will also be borne by the Navy Department. All other tests must be at the expense of the parties offering boilers for competition.

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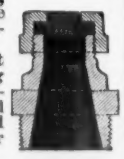

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13 1-4 in.	15 in.
16 in.	18 in.
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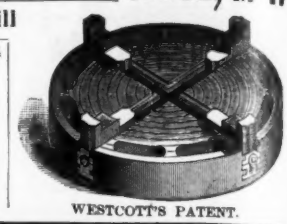
21 1-4 in.	26 in.
24 in.	30 in.
30 in.	36 in.
36 in.	43 in.



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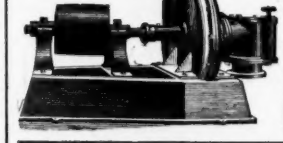

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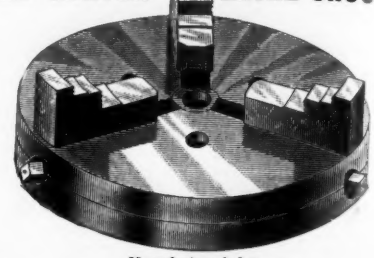

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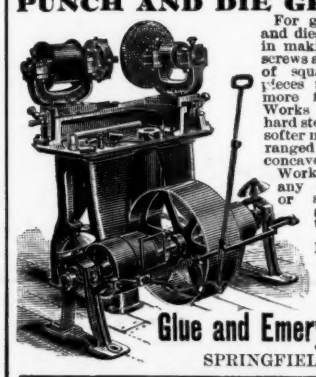

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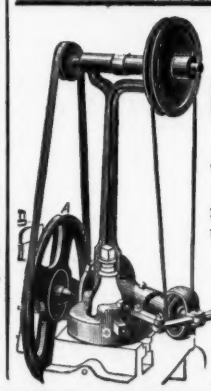

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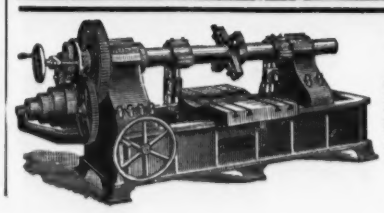

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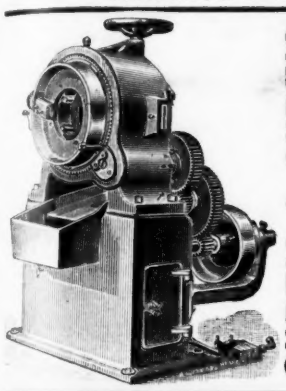

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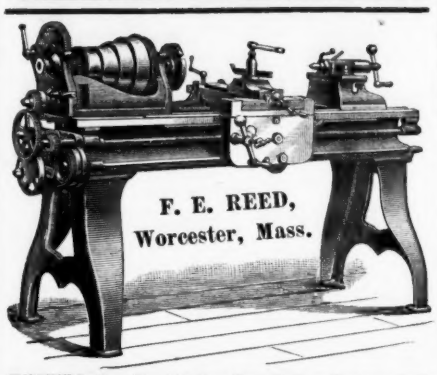

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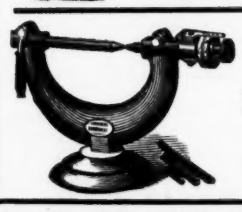

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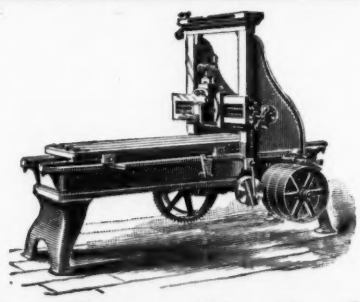

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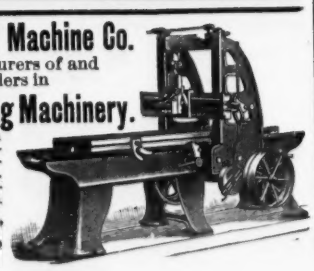

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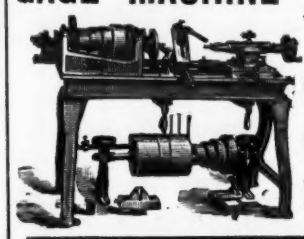

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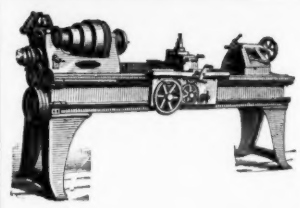

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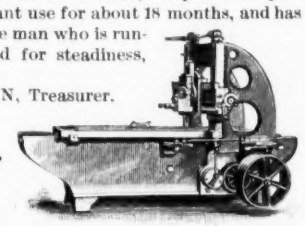

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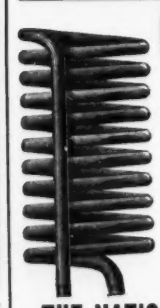

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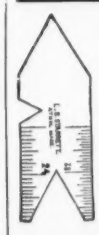

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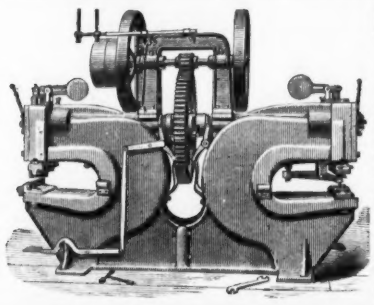

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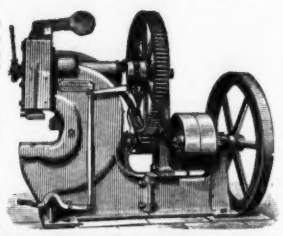

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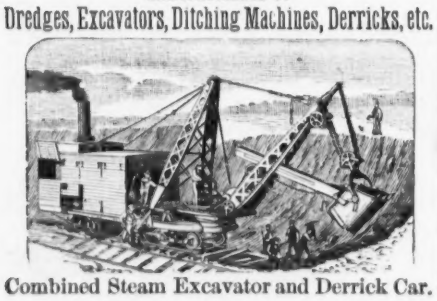

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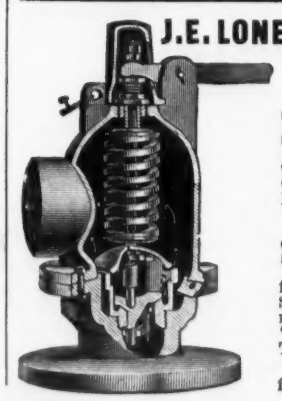

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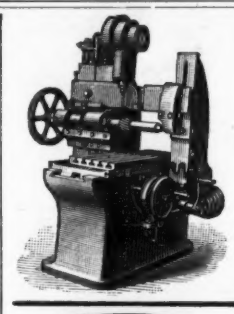

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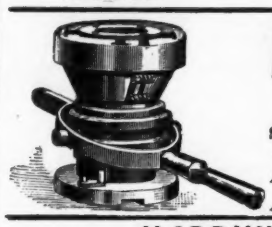

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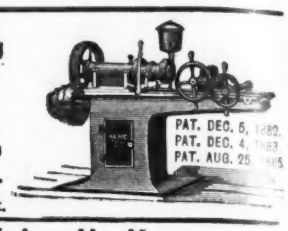

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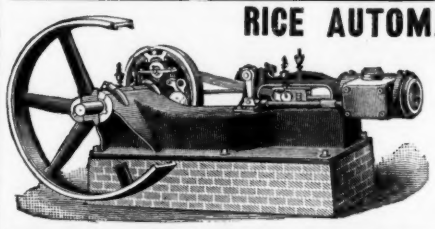

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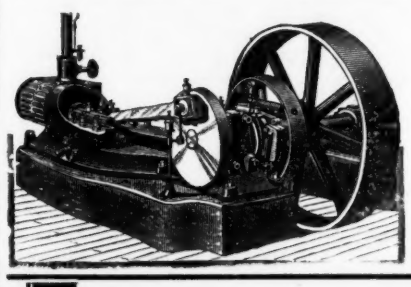

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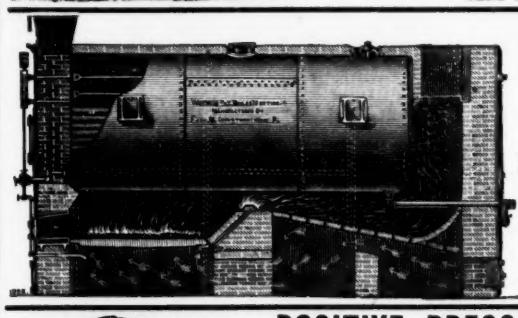

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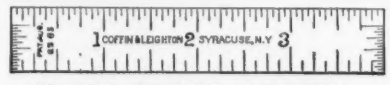

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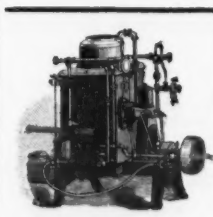

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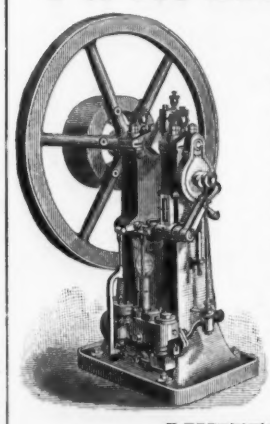

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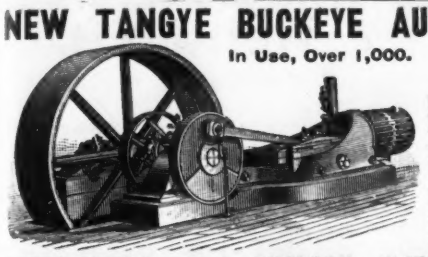

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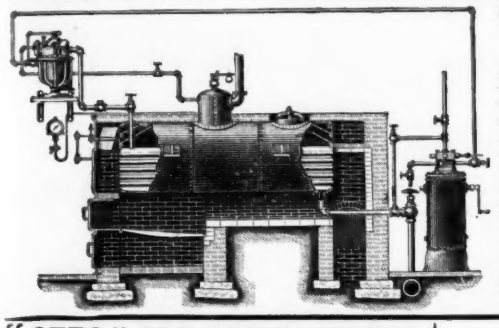

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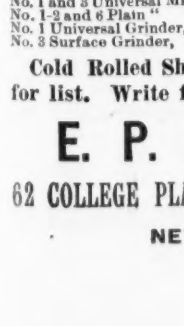

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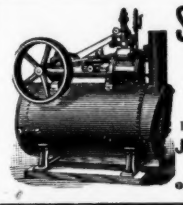

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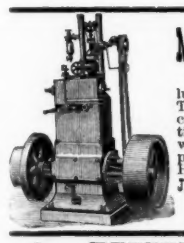

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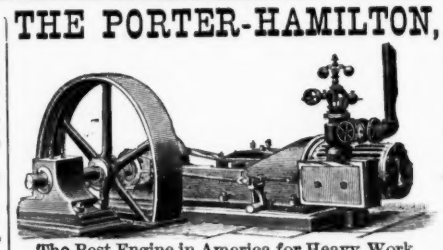

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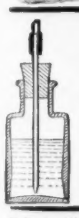

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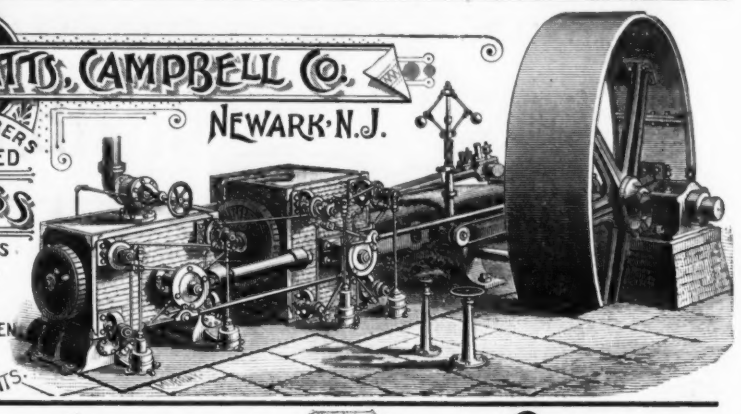

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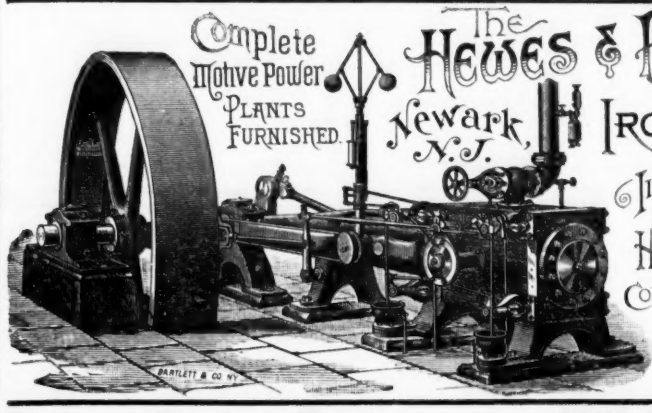

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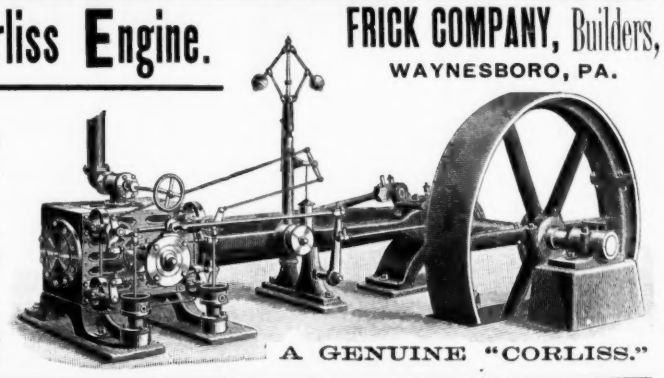

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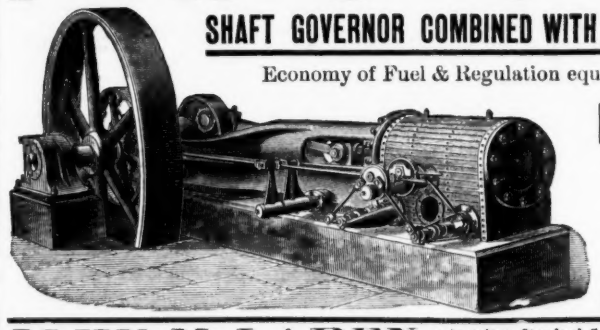

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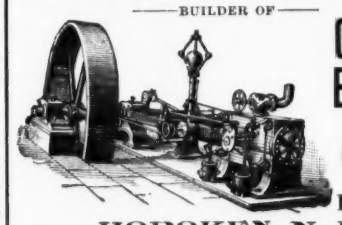

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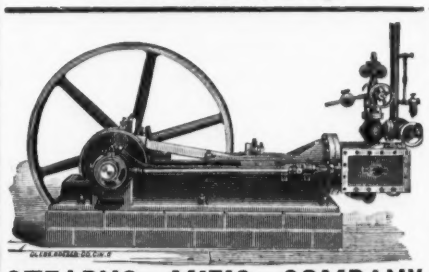

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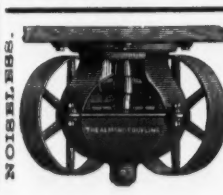

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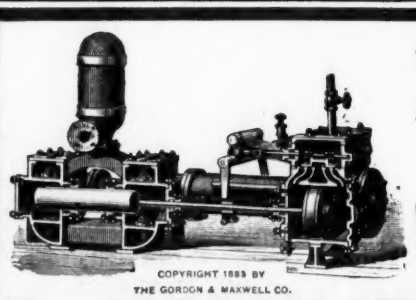

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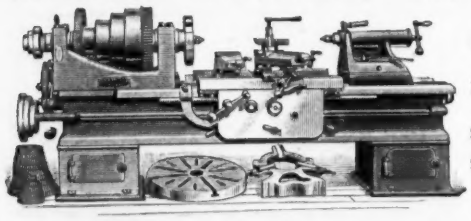

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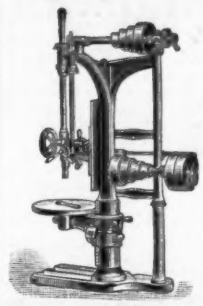

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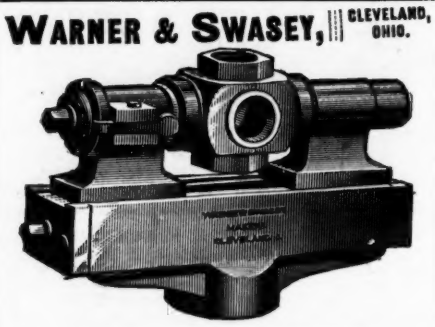

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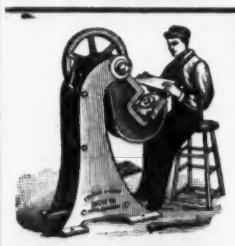

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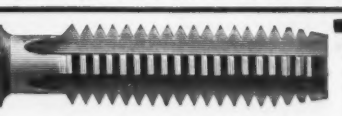

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